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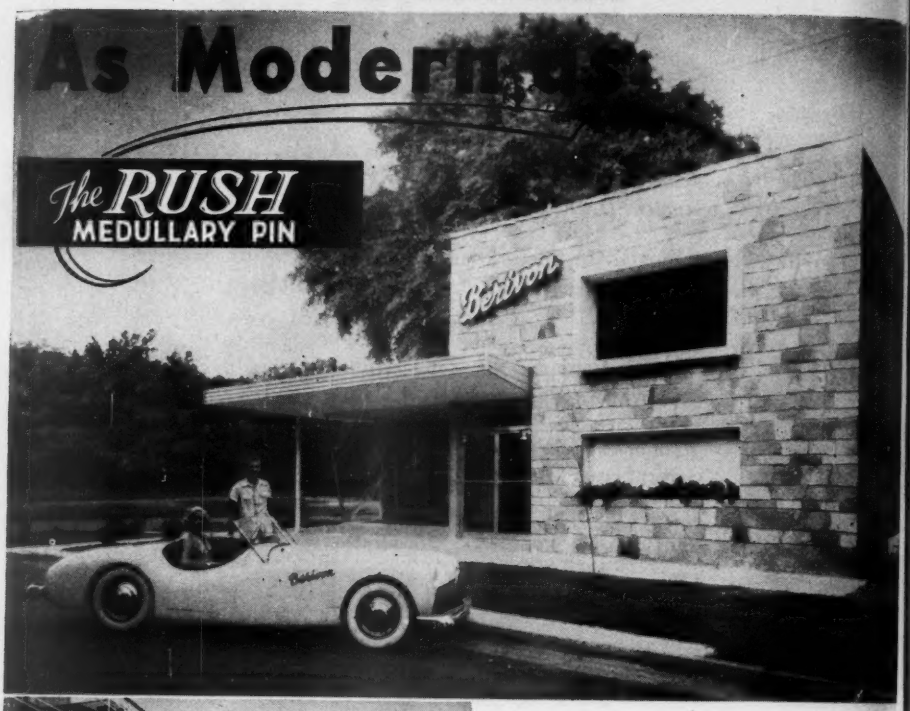

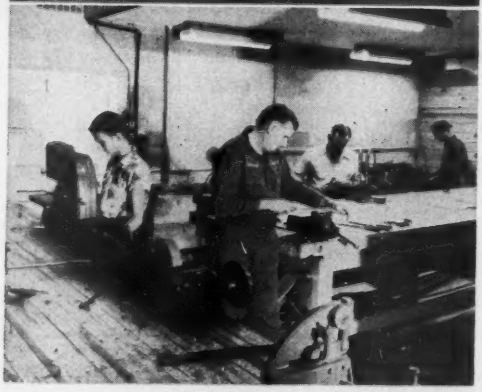

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THE CHALLENGE OF THE INTERNSHIP AND RESIDENCY PROBLEM*

HARRY LEE CLAUD, M.D., *President The Southeastern Surgical Congress*

Washington, D. C.

Officers, Members and Guests of The Southeastern Surgical Congress: To be here, in Louisville—in what I have considered since my childhood to be my *neighbor State of Kentucky*—is an honor and a privilege of which I am deeply aware. To me, this occasion is more than an honor and greater than a privilege: *it represents an opportunity.*

It is indeed fitting that we should meet here in Louisville. Two former Presidents of The Southeastern Surgical Congress have called this city *home.* These distinguished surgeons the late Dr. Alvin Abell, led us in 1940–1941; and Dr. E. L. Henderson, led us in 1946–1947. Louisville's historic traditions; Louisville's encouragement of progress, and Louisville's cordial hospitality is known to all of us.

I am especially happy to welcome those of you who have recently attained membership in our group. To these recent members it is necessary to point out that I have consciously refrained from even thinking of you as *new* members for the very word *new* has a definite chronological connotation. And—where surgery is concerned—there is neither youth nor age. The sole true yardstick in surgery is the one which *measures the degree of mastery* which one has achieved in our profession.

However, it is safe to assume that none of us has yet gained that command of the *art and science* of surgery which has been attributed to Aesculapius, our traditional founder. It was he who, according to Greek mythology, *was the object of a complaint by Pluto,* the god of the underworld. Pluto's objection was that *Aesculapius had so kept down mortality that Hades was rapidly becoming depopulated.* To remedy this situation, Zeus slew Aesculapius with a thunderbolt.

Yet, notwithstanding the alleged antiquity of our origin, ours is a young profession among the related sciences.

In Egypt early surgery was too closely allied with ritualistic religious practices for it to be ennobled into a profession.

The learned Greeks were little better. Their Olympian pantheon tolerated murder and looked lightly on practices which would ultimately destroy health. That imaginary and highly sophisticated group of gods banned the study of anatomy through the dissection of the human body.

Rome, the father of Law, tried to take over the role of gravedigger to Surgery. Rome gave us the Middle Ages—the 1,000 years of ignorance—in which a physician would *NOT* perform surgical operations. The physician of the Middle Ages considered such operations as being beneath his dignity. He passed them

* Presidential address delivered during the annual assembly of the Southeastern Surgical Congress, Louisville, Ky., March 9–12, 1953.

along to barbers, executioners and hog-gelders to do *if*—and that was a big *IF*—if they were done at all.

I place the true origin of surgery as a profession—not in the time of fabled Aesculapius, nor yet in that of Hippocrates of Coss—but rather, in 1529, when an obscure barber's apprentice from the provinces straggled into Paris. That man's name was Ambrose Paré. It was he who, seven years later in 1536, modestly stated, after having accomplished what was then a most difficult feat of surgery, "I dressed his wounds. God healed him." If Paré was *the father of surgery* as we know it—and I believe that he was—then, Vesalius, the anatomist, and Lister of antesepsis fame, *were the uncles of the new-born child.* Why? Simply because they were the *spiritual brothers of that child's father.*

Surgery was made respectable by a forgotten German king in 1404. Emperor Charles V elevated us into a profession some years later. But, even as late as the time of Baron Von Steuben, who *left Germany to aid the embattled American colonists of our War for Independence,* a part of the duty of a German army surgeon was to *shave the officers of the regiment.*

Shortly over two centuries ago, when George Washington was a young man of 21 years a newspaper was sold on the streets of New York City. We learn from the Jan. 27, 1752 edition of the New York Weekly Postboy: "Whereas, Anatomy is allowed on all Hands, to be the Foundation of PHYSICK and SURGERY, and consequently without SOME knowledge of it, no person can be duly qualified to practice either; this is therefore to inform the Public that A COURSE OF OSTEOLOGY and MYOLOGY is intended to be begun some Time in February next in the City of New Brunswick. . . . The course is proposed to be finished in the Space of a Month."

The implication of this notice is that *any person who completed such a course satisfactorily was duly qualified to practice as a surgeon.* Even at that, the *30 day short course graduates* had a distinct advantage in their medical education over the majority of their contemporaries—*who had taken no courses whatsoever.*

It is a far cry from the ignorant practitioner of the seventeen hundred and fifties to the experienced, expertly-trained surgeon of the nineteen hundred and fifties. It might be expected that our problems had been solved for us over the 200 intervening years. Some problems have been solved. But we have acquired new problems as a profession—and these problems are infinitely more complex and difficult of solution.

In turning from a *short, but intensive, study of the history of* our profession to *an equally intensive examination of the standing of our profession* as it exists today, it has been necessary for me to *call to my aid certain statistical tabulations.*

It was astonishing to me that it was possible to express a pattern of current events and trends by the employment of a relatively few statistics.

In 1921, there were 145,404 physicians in the United States; and of this number, 41,031 were located in the South. In 1949–28 years later—the total number of physicians in the United States had increased to 201,227; while those located in the South had increased to 45,886. The increase in the South had *NOT* kept pace with the over-all increase.

There were 134 physicians to each 100,000 population throughout the country in 1921: 121 per 100,000 in the South. In 1949 there were 135 physicians per 100,000 throughout the country, a slight increase over 1921. There were only 99 per 100,000 in the South, a decided *DECREASE*.

The Nation's average per 100,000 population for physicians with a limited surgical specialty in private practice was 37 in 1949; for the South—26. In 1923, 21.7 per cent of all specialists were limited specialists in surgery. In 1949, 19.2 per cent were limited specialists. Through June 30, 1951, the American Board of Surgery, established in 1937, had awarded 4,860 certificates. That, broken down over the 14 years since 1937, gives a yearly average of approximately 347. And that means a yearly growth of 347 for the *entire* United States. Less than one-third of the practicing limited specialists in surgery in 1950 held certificates from their approved examining board in their specialty.

There were 616 hospitals in the United States in 1941 which were qualified to offer residencies and fellowships. That year, 5,233 Americans took advantage of this offer. Ten years later, in 1951, 1,120 hospitals could and did make this same offer. Nineteen thousand, four hundred sixty-four internships, residencies and fellowships were offered in all fields. Yet, in 1951, only 14,595 Americans took advantage of this offer.

In 1950, there were 6,002 new graduates—6,002 new additions to our profession. We lost 3,794 physicians that year by death. Our *net gain* in that one year was only 2,208. Even 2,208 does not appear to be too promising when one considers that that number includes all licentiates in the entire United States, and that a number of these are no longer in civilian practice.

What do these statistics mean?

I shall not attempt to give *every* shade, *every* nuance, of their meaning. What I will do is to *touch*, and that *all too briefly, on the significance of these statistics to us; to The Southeastern Congress of Surgeons.*

Our profession has not been idle. Our long and arduous training in diagnosis prepared us to observe and analyze our own symptoms before those symptoms became part of the statisticians's repertoire. We decided upon the disease which was holding back our normal growth. We planned operations.

A survey of a selected group of hospitals was begun by the field staff of the American College of Surgeons on Jan. 1, 1937. This survey produced the "manual of Graduate Training in Surgery" which evolved into the "Fundamental Requirements for Graduate Training in Surgery." The first list of approved residencies appeared in January 1939—two years after the original survey started.

Representatives of the American Medical Association, the American Board of Surgery and the American College of Surgeons joined forces in 1950 as the Conference Committee on Graduate Training in Surgery. As a result of this collaboration minimum standards for approved residencies have been set up. We are working together. That, in itself, is no mean accomplishment for individualists.

President Truman's Commission on the Health Needs of the Nation issued a summary of its findings and a single volume of its multi-volume report in January 1953. It is still too early to put forth a considered opinion on the recommen-

dations contained in this report which includes the subject which I am now presenting for your consideration, or any other subjects related thereto. There is no doubt that all material contained in the report of the Commission should be and will be carefully studied and analyzed. There may be some good in this report.

On the other hand, it would be unrealistic to expect our profession to accept this report, in part or in whole, without the advantage of a sufficient time perspective. We have had full opportunity to observe attempts to socialize our profession having been made through normal legislative channels. Thus far, these overt attempts have failed. There is little reason to believe that failure *up to now* has daunted the advocates of socialized medicine. Their attempts will continue; if not through normal legislative channels, then through abnormal legislative channels. *An enemy who has been foiled in getting into our house through the front door might, conceivably, try the back door.*

Furthermore, our profession is justly suspicious of the motives of those who, although they are not of us, would change us. The ancient admonition of the Bible comes to my mind, "Physician, heal thyself!" The laws of governmental units—federal, state and local—which bind us are largely our own laws. We have considered them; we have written them, and we have steered them to their final enactment. We have done this to protect our profession from charlatans. We have done this to protect our patients from *latter-day* witch doctors. This we have done *without* outside interference or domination. We are perfectly capable, on the same basis, of arriving at and meeting our aims in connection with our medical college graduates and our residents.

What are our aims?

I believe our first aim to be—*to provide surgical care to those who need it.* The answer to this challenge is *NOT just more surgeons.* The true answer is: *better distribution of the surgeons which we now have and those who will join our ranks in the foreseeable future.* Not one of us has any desire to have our honored profession return to the hands of the butchering barber of the Middle Ages, to whom surgery was an *uncharted,* and often an *unwanted,* sideline. Not one of us wants any part of a movement to *revert our skilled profession to the ignorance, the filth, the the downright dishonesty of midwifery.* How, then, may we secure a wider distribution among interns and residents, our future surgeons, without lowering requirements?

It is unthinkable that we should lower our training standards. It is presently impractical to raise them. They cannot remain static and still meet our needs. Then, since they must move, they can only expand *OUTWARD.* How is *outward* expansion of training standards possible? A most constructive opinion on this subject has only recently been brought to my attention. It was proposed that *university hospitals should re-evaluate the requirements for and responsibilities of internes.* More *fourth-year* medical college students could be made available for ward duty, thus, releasing the internes from burdensome routine. There are numerous advantages to this practice. The interne would be able to apportion his time so that he could serve in a higher professional capacity. His experience

would be more diversified. The tempo of his acquisition of skills would be accelerated. And—perhaps, the outstanding advantage of all—the interne could be given the opportunity to continue his professional training in affiliated hospitals at a county or community level and be stimulated to seek a residency at this same level. Another proposal of like nature has been to utilize nonprofessional technical personnel to a greater extent than they are now being used for the performance of certain routine tasks usually assigned to internes. The end-motive as in the instance of the use of fourth-year medical college students, is the same: to augment the speed and the scope of the interne's professional training.

Treatment of the patient was, is, and *always will be* the reason for the being of surgery. It has been an axiom that the *method of training whereby the greatest good for the greatest number of patients is attained while, at the same time, giving regular operational experience to graduates, is the best method of training.*

There was a time, not too far past, in our American historic panorama when charity wards existed in nearly every hospital. Then, the *best method* of training was accessible to all who wished to avail themselves of it. These extensive charity wards have disappeared with the *horse and buggy days.* They remain only in certain large hospitals in some large cities. In vast areas of our country they have vanished altogether. It has come to the point that there are literally hundreds of American hospitals which meet, or surpass, the most exacting criteria that are barred from becoming graduate training institutions *solely* because they do not have enough charity beds or charity patients to qualify.

Why?

Voluntary group hospitalization Medical and Surgical Plans, which we have encouraged and abetted, erase the word *charity.* The patient is entitled to the personal attention of the surgeon who accepts his case. In a very real sense, we have created a Frankenstein monster in voluntary group hospitalization Medical and Surgical Plans. We must assert our mastery over it, rather than have it become our master.

What can we do to remedy this situation?

I propose that there should be a re-examination of the charity bed requirement. This might well elevate hospitals not now included into the category of acceptable teaching institutions. Financial borderline cases, *near indigents,* or *medical-indigent* might be substituted for *charity patients* in order to gain the needed numbers. Use of equivalent procedures—in contrast to identical procedures—might accomplish the same desired result.

When standard facilities and guidance are present, no matter where the hospital is located, it should be made available for teaching purposes through planned conformity to standards. Flexibility, as well as infallibility, should be instituted as a precept for distributing the practitioners of our profession.

Another suggestion has been made that variety in nature of operations and a comparative scale on skills needed to operate, be enforced in lieu of sheer numbers of operations.

It has been suggested that hospitals with only a two or three year training program affiliate with hospitals accredited for a full four year program. This plan

is already in use in some communities but should be encouraged and given additional emphasis by the proper authorities.

It has also been suggested that hospitals on county, private, or community levels—when those hospitals possess essential facilities and a recognized professional staff—may contribute much more than they have been doing in the past to an over-all resident training program.

While I do not crusade for any single suggestion to the exclusion of all others, and while I do believe that resident training must undergo an outward expansion, the concept of the greater use of the acceptable private, county or community hospital does present a practical and workable solution to the residency problem. This and other suggestions have been made and cannot be ignored.

It is granted that we, as a group, refuse any intimation that we lower our sights below the ultimate in scientific standards. But neither do we believe in any twentieth century projection of the intricate *taboo system of savages*. Surgery must not be bound by moronic mysticism any more than it should be bound by indefensible ignorance. It is necessary that we accomplish our first aim as the surgeons of today: to provide surgical care for those who need it. This goal must be always before us and we must move inexorably toward it.

Yet, we must never forget that there is a second goal, a second aim for each and for all. I refer to the aim, the goal, of making it possible that more fine young minds, which otherwise might be lost to our profession, should be given real assistance so that they may ultimately be directed toward the problems of surgery.

In the Oct. 17, 1952 issue of the UNITED STATES NEWS AND WORLD REPORT, there is stated that *the War in Korea and expanded armed strength calls for summoning 5,900 doctors to the colors in 1953, compared with 4,700 in 1951*. It can safely be assumed that a dramatic proportion of the numbers of professional men which I have just cited will be taken from prospective residents now engaged in some form of graduate training.

How are we going to get these men back into their chosen field, once they are released from active military duty? How are we going to acclimate a profession of peace to a world at war?

The trials of the era of our War of Independence caused a patriot to exclaim, "These are the times which try men's souls." To paraphrase that statement, in the light of present-day conditions, it would be appropriate for us to say, "These are the times which challenge our highest intellects."

How, then, may we do everything within our power to help the capable *would-be surgeon* of today in his tremendous task of becoming a surgeon? The methods which have been suggested in connection with the realization of our first aim should be re-examined for possible utilization in the attainment of our second aim.

It is specially pertinent in this instance that we do not hastily dismiss the particular suggestion about the use of capably staffed and well equipped private hospitals at the county or community level as sources of resident training.

It is becoming increasingly evident that there is a distinct trend for recent

certified surgeons to practice their specialty in the vicinity where they spent the years of their residency. Only 27 per cent of the graduates of American medical schools in the year 1935—to pick a single year at random—are now practicing in a state which was *NOT* their prior residence, or where they did *NOT* have their medical school training, their internship, or their residency. To restate this fact in a positive manner: 73 per cent of the medical school graduates of 1935 are now practicing in the state where they graduated, or where they received additional training.

This tendency for approximately three out of every four medical school graduates to remain in the state where they graduated does *NOT* aid in bringing about a distribution of surgical service on a geographical basis so as to make available those services to the greater number of our fellow Americans. This trend could be reversed.

A resident might take a year, or even two years, of his training program at a private hospital on county or community level. He might, then, complete his training program in a larger accredited urban hospital. By so doing, he would have the opportunity of living under differing conditions in *two* states, one distant from the other. I have every confidence that such a resident, when he became a surgeon, would be able to make a more considered and competent choice as to where he could better practice his specialty.

SUMMARY AND CONCLUSIONS

It is proposed that university hospitals should re-evaluate their requirements for, and the responsibility of Interns. More Fourth Year medical students could be made available for ward duty, therefore releasing a larger number of Interns for service and training in non-university hospitals. Another proposal of like nature has been to utilize non-professional technical personnel to a greater extent than they are now being used for the performance of certain routine tasks usually assigned to Interns.

Attention is called to the fact that because of a nation-wide movement towards pre-paid hospitalization and Medical Plans, there are no longer available enough medically indigent persons that fully meet the theoretical need and present mathematical requirements set up in connection with training Interns and Residents.

Since there obviously are not adequate opportunities to meet the demand for surgical training in municipal, state or university hospitals, the Conference Committee on Graduate Training should be urged to recognize the necessity for, as well as, the suitability of many county, community or private hospitals to offer acceptable training in surgery with the full understanding that in so doing, persons with pre-paid hospitalization, and even private patients should be used in connection with such training.

On these two bases it is concluded that the previous requirements of the Conference Committee on Graduate Training in Surgery, stipulating that each trainee should individually perform a rather large number of major surgical procedures, must be scaled down, without lowering the high standards of train-

ing that have been the objective of the American Board of Surgery since its organization in 1937.

The Conference Committee should be urged to recognize and give greater weight to well rounded and well supervised training courses in granting approval to hospitals, rather than placing, as at present, undue emphasis on a mathematical number of cases available to be operated upon by the trainee, unaided or even unsupervised. Training, as a part of the course, in the different fields in surgery, assisting a few highly qualified surgeons a great many times, and a reasonable number of well selected cases of progressively increasing complexity should be considered acceptable to the Conference Committee as favorable factors in connection with the hospital applying for accreditation to offer surgical training.

COMPLICATIONS OF PARTIAL GASTRECTOMY FOR PEPTIC ULCER

J. D. Martin, Jr., M.D.*, Edgar D. Grady, M.D. and William C. McGarity, M.D.

Emory University, Ga.

When peptic ulcers fail to respond to adequate medical treatment, surgical intervention is considered necessary. Operative procedures, up to 1930, consisted primarily of gastroenterostomy, pyloroplasty and excision of the ulcer, and occasionally gastrectomy.

Finsterer[2] was responsible for the popularity of gastrectomy, which, nevertheless, has developed somethat slowly. Its use has been limited to a great extent by the attendant mortality and morbidity. Recognizing the magnitude and failures of partial gastrectomy, Dragstedt[1] and Grimson[5] readvocated vagotomy in the treatment of duodenal ulcers. Since this has not entirely met the needs of all ulcers requiring surgery, its popularity has decreased during the past seven years but its value in some cases is still recognized. Continuation of partial gastrectomy, or perhaps some other procedure, seems justifiable for correction of the irreversible damages of the ulcer.

Because of the complex factors involved, some undesirable sequelae of gastrectomy are unavoidable. Three major adjuncts: antibiotics, the widespread use of blood transfusions, and improvements in anesthesia have increased the practicability of the procedure and lowered the mortality rate. It has been noted that postoperative complications have not decreased correspondingly, either in number or severity. Since 1942,[3-10] numerous reports have emphasized the various sequelae to partial gastrectomy; few have presented the immediate and delayed complications.

From July 1946 to July 1952, 520 cases of peptic ulcer were treated by partial gastrectomy at Emory University Hospital, Grady Memorial Hospital, and Lawson Veterans Administration Hospital. This report is an analysis of the early complications that occurred following these procedures, with suggestions for preventing or minimizing such sequelae.

One hundred and six (20.4 per cent) of the patients developed immediate postoperative problems, and 153 early complications. There was a mortality rate of 2.5 per cent.

The intra-abdominal complications, resulting in eight deaths, were the most serious, and were usually related to the technic in performing the operation. Postoperative hemorrhage from the upper gastrointestinal tract occurred in 16 (3.1 per cent) of all patients, with one death. The fatal case developed severe gastrointestinal bleeding immediately following the operation and failed to

* From the Whitehead Department of Surgery, Emory University School of Medicine, Emory University, Georgia.

Presented during the annual assembly of the Southeastern Surgical Congress at Louisville, Ky., March 9–12, 1953.

respond to multiple intravenous and intra-arterial whole blood transfusions. Death occurred 10 hours after the operation. The autopsy failed to reveal a definite site of bleeding. Three other patients were reoperated upon and the site of the bleeding was found to be at the gastrojejunal anastomosis. The remaining patients responded, without further surgery, following administration of 1,000 to 3,000 cc. of whole blood.

Stomal obstruction was present in 10 (1.9 per cent) of the patients. Six of these patients had a retrocolic and 4 patients had an antecolic anastomosis. They all required continuous gastric suction for 7 to 21 days following operation, and good results were obtained without further surgery.

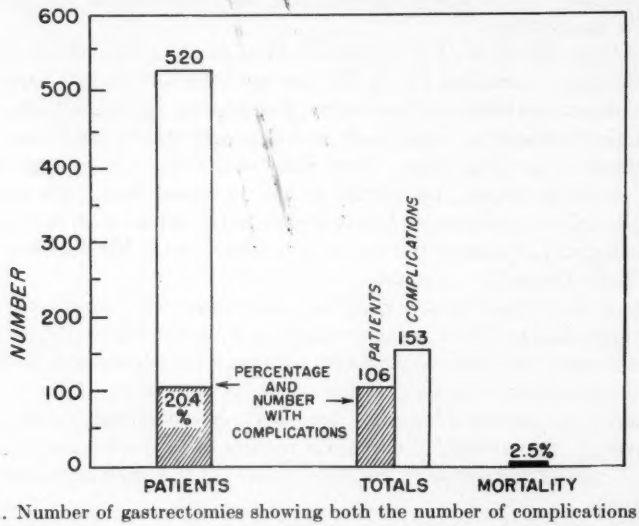

FIG. A. Number of gastrectomies showing both the number of complications and mortalities.

Duodenal fistula was the most serious of the intra-abdominal complications. Five such complications were encountered and of these 5 patients, 4 died. All of them gave a history of ulcer for 10 years or more. One patient had an emergency gastrectomy because of uncontrollable bleeding from a duodenal ulcer. In the 4 patients who died, the ulcer was either adhered to or eroded into the head of the pancreas. In attempting to remove the ulcer, it was noted that the tissue of the duodenal stump was friable, and there was difficulty in closure. In the patient who survived, the ulcer was adhered to the liver and was left attached. The duodenum was transected below and closed. The duodenal leakage in all 5 cases manifested itself within 2 to 21 days following operation.

Postoperative hemorrhage from the spleen or its pedicle occurred in 3 patients; 2 of whom died. One patient had symptoms of intraperitoneal hemorrhage 10 days following operation. An exploratory laparotomy revealed a torn spleen. Splenectomies were done on 2 other patients who showed evidence of postoperative hemorrhage, but both died soon after as the result of severe blood loss.

One pancreatic fistula occurred in this series. The patient, a 28 year old man,

gave a five year ulcer history with symptoms of persistent pyloric obstruction. At operation the ulcer was found on the posterior wall of the first portion of the duodenum, and was adhered to the pancreas. The ulcer bed was left on the pancreas, and the duodenum was transected and closed below the ulcer. Shortly after operation distention and ascites developed. The ascitic fluid contained 1,743 Bodanski units of amylase and the serum amylase was 644 Bodanski units. The patient died on the forty-eighth postoperative day. At autopsy, an open pancreatic duct was found in the ulcer bed where it had been left on the head of the pancreas. Subphrenic abscesses occurred in 4 instances. Three of these were treated by incision and drainage. All 4 patients recovered without difficulty.

CHART 1

Immediate intra-abdominal complications

	No.	Deaths
1. Hemorrhage, from upper G.I. tract	16	1
2. Stomal obstruction	10	0
3. Duodenal fistula	5	4
4. Sub-phrenic abscess	4	0
5. Hemorrhage from spleen or pedicle	3	2
6. Pancreatic fistula	1	1

Charts 1, 2, 3, 4, 5 and 6 show incidence of complications with their respective mortalities.

CHART 2

Cardiovascular complications

	No.	Deaths
1. Thrombophlebitis or phlebothrombosis	7	1
2. Pulmonary embolism	5	1
3. Cardiac arrest	2	2
4. Shock, severe	2	1
5. Myocardial infarction	2	0
6. Cerebral thrombosis	1	0
7. Auricular fibrillation	1	0
8. Sinus tachycardia	1	0

Serious wound infections, including cellulitis and abscesses, were the most frequent complications, occurring in 24 (4.6 per cent) of the patients. These were treated by incision, drainage, and chemotherapy. Evisceration occurred in 11 cases. Six of these had transverse incisions and 5 had midline incisions for their gastrectomies. Disruption of the incisions occurred from the seventh to thirteenth day. Secondary closure with through and through stay sutures was done in 9 cases. Large hematomas occurred in 9 patients. Postoperative incisional hernia developed in 7 instances. Of these, 3 patients had evisceration treated by secondary closure; 2 had hematomas in the wounds; 1 had infection of the wound; and 2 developed atelectasis following the operation. The immediate cardiovascular, respiratory, and miscellaneous complications are listed in Charts 2, 4 and 5.

Seventy-seven late complications, requiring readmission to the hospital, occurred in 56 patients (19.9 per cent). There were 7 deaths in this group. Marginal ulcer, the most severe late complication, developed in 16 patients, with 3 deaths. The remaining 4 deaths were due to (1) hemorrhage from erosion of the marginal ulcer into the middle colic artery, (2) aneurysm of the splenic artery with rupture, (3) necrosis of the duodenal stump 36 months after operation, and (4) perforated gastric ulcer. The remaining late complications are listed in Chart 6.

CHART 3

Complications of the incision

	No.	Deaths
1. Wound infection	24	0
2. Wound disruption	11	0
3. Wound hematoma	9	0
4. Incisional hernia	7	0

CHART 4

Immediate respiratory complications

	No.	Deaths
1. Atelectasis	16	0
2. Pneumonia	7	0
3. Pleural effusion	5	0
4. Aspiration of stomach contents	1	1
5. Pulmonary edema	1	0
6. Spontaneous pneumothorax	1	0

CHART 5

Miscellaneous immediate complications

	No.	Deaths
1. Homolgous serum hepatitis	8	0
2. Urinary tract infection	5	0
3. Transfusion reaction	3	0
4. Lower neprhon nephrosis, transfusion reaction	1	0
5. Acidosis, severe	1	0

Perhaps one of the most important factors involved in mortality, morbidity, and final results following resection for ulcer, is the proper selection of patients. It is believed that each patient must be carefully evaluated and the indications for operation must be definite. The criteria for partial gastrectomy for peptic ulcer are as follows:

1. Bleeding. A single major episode of bleeding in a patient over 45 years of age, who has a proved peptic ulcer, is sufficient indication for operation.[11] Patients in this age group have an inelasticity of the arteries that prevents spontaneous closing of the vessels. An elective operation should be performed after

complete recovery from the bleeding; otherwise, a subsequent episode may require emergency gastrectomy and carry a higher operative mortality.

A second major hemorrhage in a younger person is adequate indication for operation. A chronic ulcer with repeated episodes of major bleeding places the patient in the same category as the older one, because enough scar tissue will have formed around the ulcer to make hemorrhage control difficult. The scar fixes the vessel wall so that when it erodes, it cannot close with normal contractile power. The age of the ulcer can be as important as the age of the patient.

Persistent, uncontrolled hemorrhage, or bleeding of a hospitalized patient under adequate ulcer treatment demands an emergency operation. When a patient continues to bleed notwithstanding conservative treatment, it is recommended that shock be controlled by rapid blood replacement and that an immediate operation follow. Brisk bleeding may in some instances be controlled by suture. In others, if the risk is not too great, an attempt may be made to remove

CHART 6

Late complications—readmission to hospital

	No.	Deaths
1. Marginal ulcer	16	3
2. Intestinal obstruction	5	0
3. Gastric ulcer (perforation)	1	1
4. Hemorrhage from erosion of marginal ulcer into middle colic artery	1	1
5. Aneurysm of splenic artery with rupture	1	1
6. Ischemia, causalgia and atrophy of left arm following arterial transfusion	1	0
7. Necrosis of duodenal stump 36 months after operation	1	1

the bleeding ulcer bed. When uncontrolled bleeding of doubtful etiology occurs, the patient should, if possible, be given barium swallow and have a careful gastrointestinal series made before further operation.

2. Persistent or recurrent pyloric obstruction. Many patients develop pyloric obstruction from peptic ulcer. After improvement under good medical management, these patients are usually discharged from the hospital, only to return with a recurrence of more severe obstruction. This may sometimes be corrected by more intense medical treatment. For persistent or recurrent obstruction, however, a partial gastrectomy with creation of an adequate stoma will provide more gratifying and permanent relief.

3. Disabling ulcer symptoms notwithstanding excellent medical care. If a chronic ulcer fails to heal and sufficient symptomatic relief cannot be obtained, an operation may be recommended. Patients in this group are the most difficult to evaluate and those in whom the least satisfactory results are obtained both medically and surgically.

4. Gastric ulcer. A three to four week period of rigid medical management is

permissible to determine if an apparently benign ulcer can be healed. If it does not, operation is mandatory.

5. Perforated peptic ulcer. Perforation of an ulcer in itself is not considered sufficient indication for partial gastrectomy. It is, however, a factor to be considered in evaluating a particular ulcer-patient. A history of perforation in combination with any of the above criteria, will influence the decision in favor of operation. Two episodes of perforation of a peptic ulcer is considered sufficient indication for partial gastrectomy.

DISCUSSION

Because of the general depletion of body reserves, an emergency operation for uncontrolled hemorrhage carries an increased complication risk. The combined stress of the hemorrhage and the major operative procedure may be too great for the patient to survive. Indeed, this accounted for 5 (41.7 per cent) of our postoperative deaths, and also for death of a sixth patient who was operated upon for uncontrolled bleeding from a marginal ulcer. Several factors contribute to the increased hazard. The forces to combat stress and shock may have become exhausted. Impairment of circulation to the vital organs may render them more liable to subsequent damage. Repair of traumatized tissues is diminished as a result of local and systemic changes. The abdominal wall may become so weakened that intestinal and gastric suture lines become subject to disruption or infection. The blood clotting mechanism can be altered by replacement with a large volume of citrated blood which increases the possibility of postoperative bleeding and wound hematomas. It is, therefore, desirable to defer operative intervention during and immediately following the hemorrhagic phase.

Postoperative hemorrhage from the stomach or duodenum originates from the original disease, from the operative incisions, or from traumatized gastric mucosa. An unremoved ulcer may be a source of postoperative bleeding. It is considered essential to ligate all the bleeding vessels in the stoma and jejunum during the anastomosis.

The cause for postoperative stomal obstruction is seldom proved, because it is nearly always transient. Keeping the patient under observation and employing gastric suction and parenteral alimentation with attention to electrolyte and protein balance will usually suffice. The primary cause of the obstruction has often been found to be reactive edema, a hematoma, or a stitch abscess. Faulty placement of the anastomosis may cause angulation of the jejunum. In postcolic anastomoses, the opening of the jejunum should be made as near the ligament of Treitz as possible. Postoperative intestinal obstruction occurred in 5 of our patients.

A duodenal fistula is the most serious of all complications. To prevent this development, a compromise procedure is preferable in cases where resection would carry a greater risk. The area of the ulcer, the first and second portions of the duodenum, the porta hepatis and the common bile duct are exposed when possible. This dissection may reveal hazards of such significance that further procedure is contraindicated. When exposure is possible, the common duct is

identified; the foramen of Winslow is demonstrated; the hepatic artery is palpated and located in relation to the stomach and duodenum, and the relation of the ulcer to the common duct and pancreas is determined. It is often helpful to reflect the edge of the duodenum on the convex right side, from the pylorus as far inferiorly as the common duct. Lahey[7] suggests beginning the dissection distal to the common duct and, if necessary, inserting a long T tube into the common duct and through the ampulla of Vater. If there is a thickened peritoneum on the anterior wall of the duodenum, incision throughout its length will aid both in evaluation of the process and mobilization of the duodenum. When the results of preliminary examination and dissection indicate a compromise procedure, gastroenterostomy with vagotomy may prove satisfactory. On some occasions

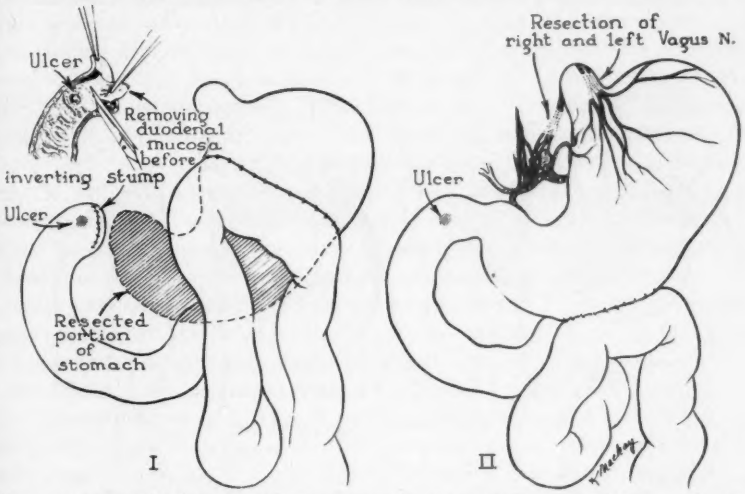

FIG. 1. Shows the Finsterer method of exclusion of duodenal stump with resection of the stomach.
FIG. 2. Ulcer is left in situ. The right and left vagus nerves resected. Gastrojejunostomy done.

a longitudinal gastroduodenotomy is made across the pylorus for inspection of the ulcer. If, after this, a resection is impossible, a Heineke-Mikulicz or Finney pyloroplasty may be done with vagotomy. It must be remembered that a chronic ulcer of the duodenum may shorten the distance between the pylorus and the ampulla.

After resection of an ulcer the duodenal stump cannot always be secured. Adequate mobilization of the posterior duodenum, leaving a longer anterior duodenal cuff, and avoiding the ampulla of Vater and the common duct aid in securing a satisfactory closure. An open duodenal lumen is usually more satisfactorily closed than when a clamp has been used. It has been emphasized by Warren[12] that sutures into the substance of the pancreas may lead to disaster. The scar tissue around the ulcer may, however, be useful as a reinforcing layer for covering

the duodenal stump. If there is doubt as to the security of the stump closure, or possibility of pancreatic damage, it is wise to drain the area of the duodenal stump.

The occurrence of a pancreatic fistula postoperatively is also related to the handling of the peptic ulcer and duodenal stump. A gastric or duodenal ulcer may adhere to and erode into the pancreas resulting in a fistula. Any injury to the pancreas must be avoided in the dissection of the adhered stomach and duodenum. A pancreatic duct may accidentally be transected during the process of freeing the duodenum. Any tubular structure must be identified before it is sacrificed—aspiration is an aid in this. The duct under consideration may usually be safely ligated. In other instances, however, ligation may lead to pancreatitis or to the formation of a fistula. Milbourne,[8] after studying the relationship of

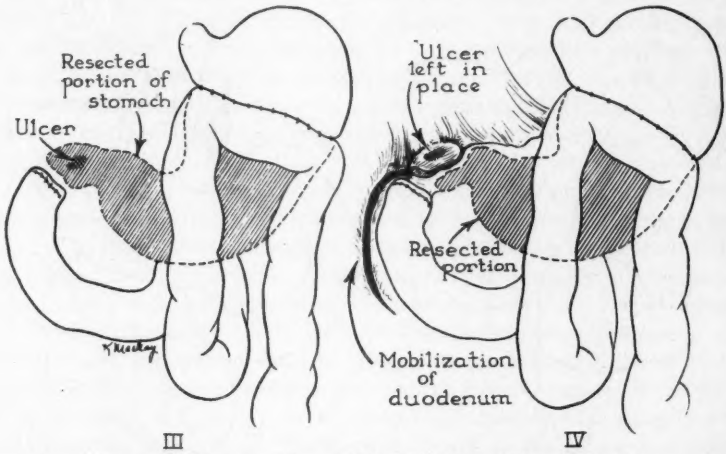

FIG. 3. Showing resection of ulcer with three-fifths of stomach.

FIG. 4. Showing the ulcer left in situ due to its adherence and inability to safely resect. Duodenum turned in and closed. In addition, approximately three-fifths of stomach is resected.

the ducts, concluded that the duct of Wirsung serves as chief efferent channel of the pancreas in 90 per cent of the cases. In the other 10 per cent, the duct of Santorini may play a substantial or even major role. There may be multiple communications between the two ducts, or none at all. In the latter event, ligation of the duct of Santorini may prove disastrous.

Subphrenic or subhepatic abscess usually results from more than a simple contamination and is believed often to be associated with pancreatitis and fat necrosis, a small biliary or pancreatic fistula, or leakage from the gastric or intestinal suture line. Since it is impossible to eliminate contamination, penicillin and streptomycin are administered postoperatively.

Severe postoperative intraperitoneal hemorrhage is most often the result of bleeding from the spleen or its pedicle and requires immediate reoperation. Tearing of the spleen or its pedicle is most apt to occur when there has been a previous gastric operation. At the conclusion of a partial gastrectomy, the spleen should

be inspected for bleeding. A bleeding splenic vessel may be safely controlled by ligature; however, if there is a break in the splenic capsule, splenectomy must be done. Extreme care should be exercised in preventing intra-peritoneal hematomas. All tissue must be handled as gently as possible in order to minimize this complication.

Uncontrolled hemorrhage, requiring emergency procedures is frequently associated with imbalances of proteins, fluid, electrolytes and blood. In these patients there is also a tendency toward poor healing and wound complications. Hemostasis must be exact, and the wound must be carefully closed in layers.

Wound infection, hematoma, disruption, and hernia of the incision are each related to two situations. The first is lack of precise technical care and attention to operative details. The second is debility of the patient, either acute or chronic.

Pulmonary complications tend to occur most frequently in the elderly and in those patients who are prone to wound complications. Spontaneous pneumothorax or vomiting may occur in patients with emphysematous pulmonary blebs, while they are under anesthesia. Bronchoscopy may be indicated at the end of the operation to clear the airways of aspirated or retained material. On the first postoperative day, the patient is encouraged to cough. If necessary, endotracheal suction is utilized to clear the respiratory tract. Pleural effusion is usually the result of underlying lung disease, although it may be secondary to a subphrenic abscess. As a precautionary measure, a preliminary chest roentgenogram and evaluation of the lungs should be made on all patients prior to operation.

Elderly patients are also more prone to operative and postoperative cardiovascular complications. In this group, constant vigilance must be maintained and every known prophylaxis employed against these developments.

Intra-arterial transfusion was responsible for one unusual complication in this series. A patient developed ischemia, causalgia and atrophy of his left hand and forearm following such a transfusion. It is usually necessary to ligate the artery in which the transfusion is given. The radial artery is most commonly chosen. In those rare instances in which there is no anastomosis between the radial and ulnar arteries, ligation of the radial artery will be accompanied by ischemia to the area. An additional factor to guard against is the severe arterial spasm produced when refrigerated blood is rapidly introduced into an artery. It is recommended that the transfusion blood be warmed to room temperature if time permits, and that novocaine be added to it.

SUMMARY

1. The mortality from partial gastrectomy for peptic ulcer has been appreciably lowered in recent years, but the immediate morbidity has remained high.

2. A review of 520 cases of partial gastrectomy for peptic ulcer is presented, with detailed analysis of the immediate and delayed complications which followed in 20.4 per cent of the cases.

3. These complications are divided into two major groups:

a. Those related to technical problems of the procedure.

b. Those related to the general condition of the patient, with respect to the ulcer and to other factors.

4. The problems connected with performance of the procedure merit serious consideration, for attention to these can help lower the incidence of complications.

5. The most serious immediate complications were related to closure of the duodenal stump and to postoperative bleeding.

6. The most frequent complications were related to the abdominal wound. Evisceration was the most serious in this group.

7. Suggestions are presented for the prevention and treatment of these complications.

8. A discussion of the indications for gastrectomy is presented. The criteria are based on the prognosis of the disease process versus the risks inherent in the procedure.

9. A more careful screening of the patients for gastrectomy must be made, evaluating both the indications for the procedure and the general condition of the patient.

10. The benefits derived from the procedure justify the risk if the following points are observed:

a. Careful evaluation of the patient.

b. Attention to the most minute details of the operation.

c. Excellent general postoperative care.

We wish to express our appreciation to Dr. Lon Grove and staff of Emory University Hospital, Dr. Ira Ferguson and staff of Grady Memorial Hospital and the staff of Lawson Veterans Hospital for their kind permission to use their cases in this report.

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EXCISIONAL THERAPY OF AORTIC ANEURYSMS

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Aneurysms of the aorta have long been recognized as grave problems in which treatment has been generally unsatisfactory. The gravity of the condition has been well demonstrated by a number of observers who have analyzed relatively large series of cases.[2, 5, 8, 9] Although, according to these observers, there is some variation in duration of life after onset of symptoms or establishment of diagnosis depending upon the location and nature of the lesion; there is general agreement that it is relatively short and in more than half the cases ranges between six months and two years. Indeed only a small proportion of patients survived more than several years. Until relatively recently the various methods of therapy which have been used have not yielded satisfactory results and at best may be considered palliative in nature. In general they have been concerned with the promotion of thrombosis and fibrotic organization by various means including particularly partial, complete, or gradual occlusion of the parent vessel, introduction of foreign material, or fibroplastic agents. Because of increasing dissatisfaction with these methods of therapy and because of the demonstrated lethality of the disease, a more aggressive approach to the problem seemed justifiable. Accordingly, during the past few years we have directed our efforts towards ideal surgical therapy, consisting of extirpation of the diseased part and restoration of normal function wherever possible or essential.[3] Although it has not been possible to apply this form of therapy in all cases encountered, our experience, like that of Bahnson[1] and Dubost and associates,[4] has led us to the conviction that it is the procedure of choice and may be used much more frequently than previously realized.

The application of this form of therapy is dependent upon several factors, the most important of which are the location and the nature of the lesion. Thus, sacciform aneurysms in which the neck is relatively small and the wall of the parent vessel is suitable for suture, as is most frequently encountered in syphilitic lesions, may be excised with lateral arteriorrhaphy to repair the aortic defect. This procedure may also be used when the aneurysm involves the major vessels of the aorta even though they may be fusiform in type. Such aneurysms are most frequently encountered in the upper thoracic aorta, particularly about the aortic arch. On the other hand, aneurysms in the lower reaches of the aorta, particularly in the abdominal region, are more likely to be arteriosclerotic in origin and fusiform in type. Consequently, their extirpation usually requires excision of a varying segment of the aorta itself with the aneurysm, thus precluding the use of lateral aortorrhaphy for repair of the defect. Under these circumstances temporary arrest of the circulation in the aorta distal to the origin of the aneu-

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rysm must be done during its excision, and the defect in the excised segment of the aorta must be bridged to restore normal circulation.

Aneurysms involving the arch of the aorta present a special problem in regard to operative exposure. For the most part, when the roentgenogram reveals a mass to the right of the mediastinum, the aneurysm involves the ascending aortic arch, whereas those presenting on the left involve the descending arch. For lesions of the ascending and transverse portions of the arch, we use a right anterior third or fourth intercostal space for the initial thoracotomy (fig. 1a). Through this approach and after preliminary dissection about the lesion the feasibility of excision is ascertained before proceeding further. Wider exposure is obtained by extending the incision through the sternum medially and cephalad dividing the body and manubrium of the sternum into the suprasternal notch (fig. 1a). Because of extensive involvement of the sternum or because of extension of the lesion into the left hemithorax, the sternal splitting incision may be inadequate or unsafe, and under such circumstances the sternum is divided transversely at the level of the intercostal space. Although it may not be necessary to do so, in most instances the left pleural cavity is opened. Careful attention is demanded of the anesthetist to maintain adequate aeration of the lungs in the presence of a bilateral open thorax. The incision to the left of the sternum may be extended cephalad by dividing costal cartilages or laterally into an interspace on the left side. By inserting a large rib spreader adequate exposiure is obtained to extirpate the aneurysm.

In all instances where excision is to be carried out, wide exposure of the aorta proximal to the lesion is recommended and ordinarily involves incising the pericardium over the base of the heart. Usually the aneurysms are large and may be eroding the sternum or ribs. Where possible in such cases the neck of the aneurysm should be occluded before the incision is extended; otherwise the sac may be entered. Occlusion of the base of the aneurysm is facilitated by having available special clamps with long blades which hold securely without crushing. After occlusion of the base of the aneurysm is accomplished, the sac is opened and blood and clot are evacuated. The sac is excised, and the base is closed with a proximal layer of interrupted mattress sutures of no. 000 silk and the edges oversewn with figure of eight sutures of no. 0000 silk (figs. 2a, c, d). In all cases of sacciform aneurysms of the aorta where tangential excision of the lesion is accomplished, this method of suture is used and has been satisfactory.

Aneurysms involving one or more of the major tributaries of the aortic arch may present a special problem in that extirpation of the lesion may necessitate sacrificing a common carotid artery (fig. 2b). In such cases a preoperative test of carotid occlusion should be made. In our experience the carotid artery arising from the aneurysm itself may be partially thrombosed or so distorted that collateral flow to the brain had been established and the carotid artery is sacrificed without serious neurological sequelae. Sacrificing the subclavian arteries rarely causes ischemic changes in the corresponding upper extremity, but simultaneously dividing the subclavian and carotid on one side as done in a lesion of the innominate artery is more likely to produce ischemic complication (fig. 2b).

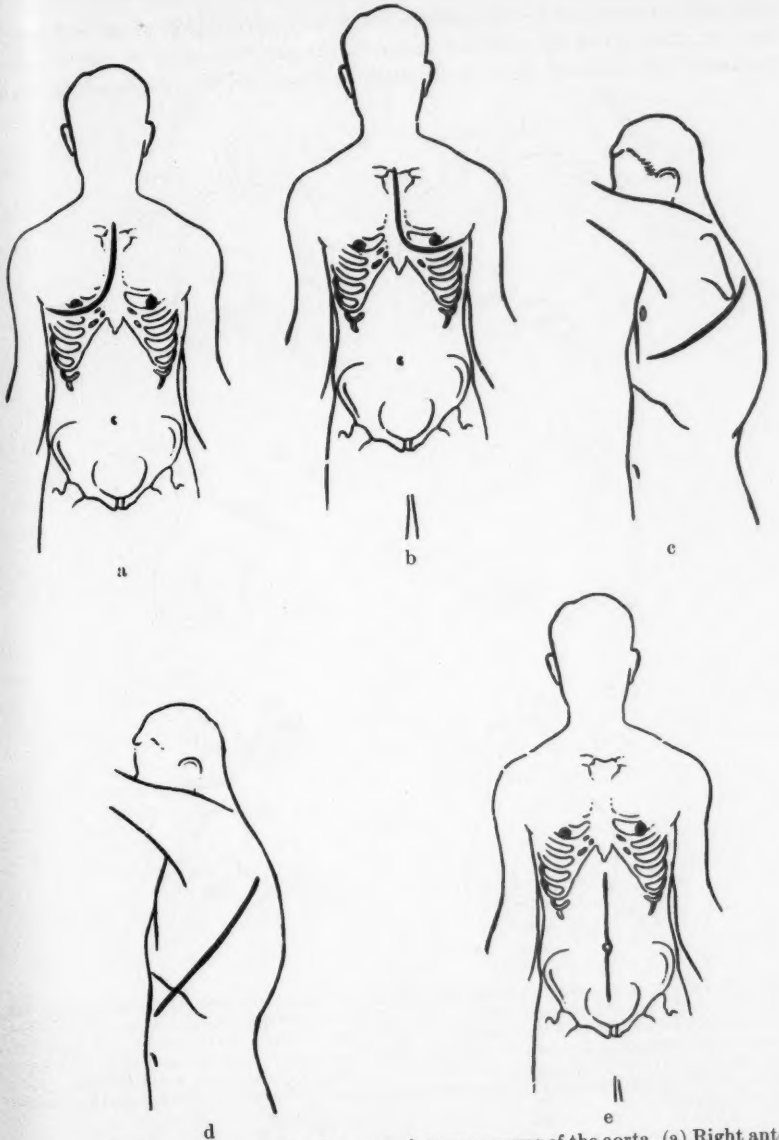


FIG. 1. Drawings showing surgical approach to aneurysms of the aorta. (a) Right anterolateral thoracotomy through third or fourth interspace combined with median sternotomy for aneurysms of the ascending or transverse portions of the arch of the aorta. (b) Similar approach used on left side for lesions of descending arch of aorta. (c) Left lateral thoracotomy approach for lesions involving the descending thoracic aorta. (d) Left thoraco-abdominal approach for aneurysms involving the lower thoracic and upper abdominal aorta. (e) Midline abdominal incision for lesions of the abdominal aorta.

Although we have had no clinical experience with restoration of carotid circulation by insertion of an arterial homograft, the procedure may in some instances be useful in protecting the patient against serious cerebral complications. Under

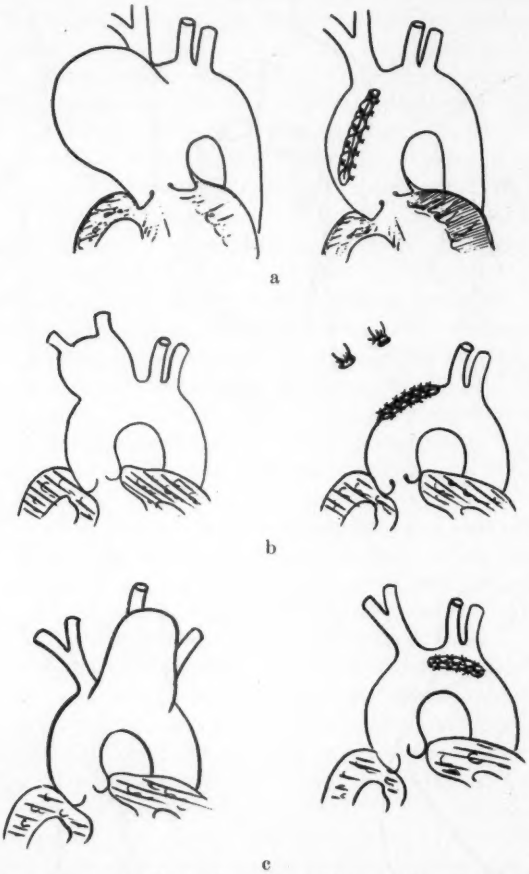
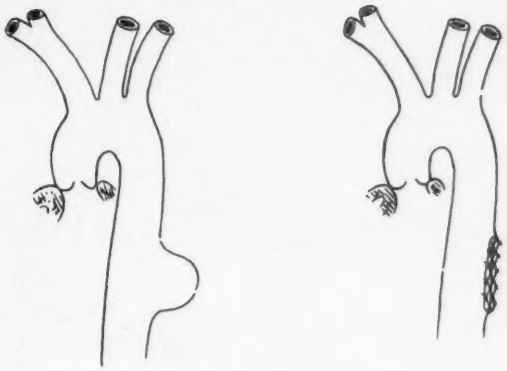


FIG. 2. Drawings showing methods of excisional therapy of aortic aneurysms depending upon type and location of the lesion. In each of these drawings the character of the lesion is indicated on the left and the method of excisional therapy on the right. (a) Sacciform aneurysm of ascending arch of the aorta treated by excision and aortorrhaphy. (b) Aneurysm involving innominate artery treated by excision, aortorrhaphy, and ligation of distal ends of vessel. (c) Aneurysm of the transverse portion of the aortic arch treated by excision and aortorrhaphy.

these circumstances a by-pass or shunt may be used to provide cerebral circulation during the period of carotid occlusion.

The approach to lesions involving the descending limb of the aortic arch is usually through the anterior third left interspace and may be extended by median

d



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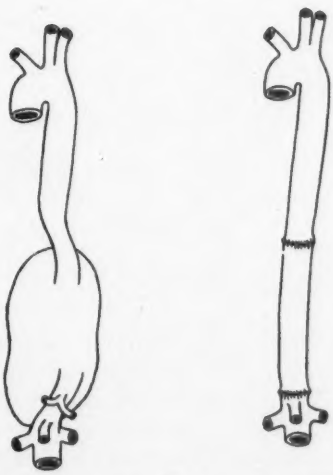
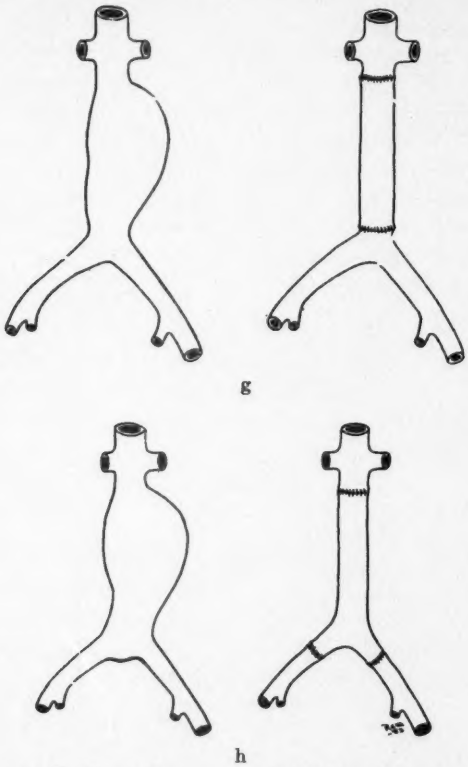


f

FIG. 2. d, e and f. (d) Sacciform aneurysm of descending limb of aortic arch. (e) Sacciform aneurysm of descending thoracic aorta. (f) Fusiform aneurysm of lower thoracic and upper abdominal aorta treated by complete excision and insertion of aortic homograft.

FIG. 2 *continued on next page.*

sternotomy or transverse division of the sternum and bilateral thoracotomy depending upon the extent of the lesion (fig. 1b). Similar principles as described above are used in dealing with the aneurysm itself, the major objective being the exposure of the neck of the sac in order to apply the occluding clamp thus permitting subsequent safe mobilization and extirpation of the sac (fig. 2d).



g h

FIG. 2. g and h. (g) Fusiform aneurysm of the abdominal aorta treated by excision and homograft. (h) Abdominal aneurysm involving the abdominal aorta and bifurcation treated by excision and aortic homograft.

For lesions involving the thoracic aorta below the arch, a left lateral thoracotomy approach, resecting a rib at the level of the aneurysm provides satisfactory exposure (fig. 1c). Depending upon whether the lesion is sacciform or fusiform in type, removal of the aneurysm may consist of simple tangential excision with lateral aortorrhaphy or resection of a segment of the aorta itself with replacement by an aortic homograft (figs. 2e, f). The special considerations dealing with the latter procedure are dealt with below.

Most aneurysms of the lower thoracic or the abdominal aorta involve a considerable segment of the parent vessel. Although in the former region they are

usually syphilitic in origin and sacciform in type, the aortic wall tends to be so extensively incorporated in the sac as to preclude its use in repair of the defect after excision of the aneurysm. In the abdominal aorta the aneurysms are more commonly arteriosclerotic in origin and fusiform in type. Accordingly, extirpation of these aneurysms usually necessitates resection of varying segments of the aorta itself, the performance of which introduces two technical and physiologic considerations. The first of these is concerned with arrest of the circulation during the performance of the procedure and the other with subsequent restoration of the circulation. The former is of particular importance in cases in which the aneurysm is located above the major tributaries of the abdominal aorta. Under these circumstances aortic occlusion and consequent arrest of the circulation distally may produce significant ischemic changes in the tissues below the point of occlusion, particularly in the spinal cord and the kidneys which have long been recognized to be highly sensitive to acute diminution of blood flow. As a result of our experience with 2 cases of aneurysm located in this region in which there was no residual evidence of renal or spinal cord damage after the aorta was occluded for 22 minutes in 1 and 45 minutes in the other, we are inclined to believe that in such cases the safe period of arrest of the circulation may be considerably extended over the normal. Conceivably, under these circumstances two factors may alter the normal hemodynamics, namely: the gradual development of a collateral blood supply and the gradual accommodation of the tissues to a diminished blood flow distal to the aneurysm. Obviously, no definite conclusions can be drawn from only 2 cases, and better understanding of the matter must await further experience. There is, however, another solution to this problem should further observations reveal the safe period of occlusion to be shorter than that indicated by our limited experience. This involves the use of a by-pass to shunt blood around the occluded segment of aorta. Although we have had no clinical experience with this procedure, its feasibility has been demonstrated experimentally. Still another measure which may be of value in this connection and which we have used in our cases is the use of a small quantity (10 mg.) of heparin solution injected into the aneurysm just before occluding the aorta to combat the possible thrombophilic effect of the retarded blood flow in the distal vascular bed.

This problem is of much less importance in cases of aneurysm involving the abdominal aorta because the great majority of them arise below the origin of the renal arteries. This is a long recognized pathologic feature of these lesions. Fortunately also in most cases there is a sufficient margin of aorta between the renal vessels and the aneurysm to permit application of the occluding clamp without interrupting blood flow to the kidneys. This has been true in all of our cases. Arrest of the circulation in the pelvis and lower extremities following such occlusion for periods ranging between 48 and 105 minutes has not been followed by any evidence of residual ischemic changes in these parts. Indeed, circulation in the lower extremities actually seemed much improved following the operation.

The other important technical and physiologic consideration in the extirpation of aneurysms in which a segment of the involved aorta must also be removed is

concerned with restoration of continuity and blood-flow. The use of aortic homografts for this purpose has been found quite satisfactory in our experience. The grafts in our cases were obtained under sterile conditions from relatively young and healthy individuals shortly after death from injury or hemorrhage. Various methods of preservation may be used, but we have preferred to preserve them at a temperature of 0 to 4°C in media as recommended by Gross and associates.[7] The longest period of preservation prior to use in our cases was 25 days, although this period may be extended up to several months. In cases in which the aneurysm does not involve the bifurcation it is preferable to use a homograft of thoracic aorta because its slightly larger caliber provides better approximation.

With increasing experience the essential steps in the operative procedure for these aneurysms have become fairly well standardized. For aneurysms arising in the lower thoracic and upper abdominal part of the aorta, adequate exposure may be obtained by a left thoraco-abdominal approach through the resected bed of the ninth or tenth rib with radial division of the diaphragm and mobilization of the visceral structures forward and to the right (fig. 1d). For aneurysms involving the abdominal aorta below the origin of the renal vessels, an abdominal approach is preferred using a midline incision extending from a point well above and below the umbilicus (fig. 1e). The aneurysm and the aorta in this region are then exposed by mobilization of the small intestine and its mesentery to the right and division of the peritoneum overlying the aneurysm along with the ligament of Treitz to permit mobilization of the duodenum to the right. By careful sharp and blunt dissection the aorta above the aneurysm is first exposed and encircled with umbilical tape, following which the aorta or the iliac vessels if the aneurysm involves the bifurcation is similarly prepared. The aneurysm itself is then freed from its surrounding structures, particular care being exercised to avoid injury to the vena cava which is often intimately adhered to the posterior wall of the aneurysm. Under these circumstances it may be desirable to delay further separation of these structures until after occluding clamps have been applied to the aorta above and below the aneurysm. The aneurysm is then excised leaving, if necessary, a thin portion of the posterior wall of the aneurysm that may be intimately adhered to the vena cava. The excised segment of aorta is then replaced by the previously prepared aortic homograft, which must consist of the terminal abdominal aorta and iliac vessels if the bifurcation has been removed with the aneurysm (figs. 2g, h). In such cases, after performing the proximal anastomosis and one of the iliac anastomoses, blood flow through the graft may be permitted during the performance of the other iliac anastomosis by applying an occluding clamp to this segment of the graft and releasing the other clamps. A simple continuous through and through suture of no. 0000 arterial silk is considered the preferable method of anastomosis and appears to facilitate the procedure in the presence of atheromatous changes in the aortic wall.

Our experience with the procedure of excision and replacement with aortic homograft in 10 consecutive cases of aneurysms involving the lower thoracic and abdominal aorta leads us to believe that it is the method of choice and may be

applied successfully in most cases. In this series there was only one death, occurring on the thirteenth postoperative day, of progressive uremia and secondary hemorrhage in a 74 year old woman who was recognized as a poor surgical risk because of impaired renal and cardiac function. Operation was advised, however, because of rapidly increasing severity of symptoms and apparent imminence of rupture of the aneurysm. All the other patients had an uncomplicated postoperative course, and none showed any manifestations of visceral or peripheral ischemic changes as a consequence of the temporary aortic occlusion which averaged about an hour. Actually most of the patients showed evidence of improved circulation in the lower extremities following operation.

All of the patients in this series were over 60 years of age except 2 in whom the aneurysm was of syphilitic origin. In all the others the lesion was arteriosclerotic in origin and involved the bifurcation in 5 instances. Hypertension of moderate degree was present in 3 cases. All of the patients showed varying degrees of atheromatous changes and roentgenologic evidence of calcification in the aorta. Thus, none of these factors necessarily constitutes contraindications to operation. Indeed, we are inclined to believe that the only contraindications to operation are concerned with severe impairment of vital functions, particularly those involving cardiopulmonary and renal organs.

Final evaluation of the procedure obviously requires further experience and longer follow-up observations. On the basis, however, of these early gratifying results and the apparently good long-term results obtained by the use of aortic homografts in coarctation,[6] there is reason to believe that this method of therapy provides the most effective surgical approach to the problem of aneurysms of the aorta.

SUMMARY

The grave prognosis of aneurysms of the aorta and the relatively unsatisfactory results obtained by most previously used forms of therapy emphasize the need for a more aggressive approach to the problem directed towards extirpation of the lesion.

The application of this form of therapy is dependent for the most part upon the location and nature of the lesion. Thus, sacciform aneurysms in which the neck is relatively small and the wall of the parent vessel is suitable for suture may be excised with lateral arteriorrhaphy to repair the aortic defect. Such lesions are most likely to be syphilitic in origin and are most frequently encountered in the upper thoracic aorta, particularly about the aortic arch. The preferable exposure for such lesions involving the ascending and transverse portions of the arch consists of a right anterior thoracotomy through the second or third interspace with cephalad extension by median sternotomy or with extension into the left hemithorax by transverse sternotomy as the situation demands. For lesions involving the descending limb of the aortic arch a similar thoracotomy approach is used through the left side.

Aneurysms in the lower reaches of the aorta tend to be more extensive and to involve a segment of the aorta itself. This is particularly true of those in the

abdominal region which are more likely to be arteriosclerotic in origin and fusiform in type. Accordingly, their extirpation usually requires excision of a varying segment of the involved aorta with the aneurysm and bridging of the defect in the aorta by means of an aortic homograft to restore normal circulation. During the performance of this procedure temporary arrest of the circulation in the aorta distal to the origin of the aneurysm is necessary, raising the question of possible ischemic damage to the tissues below the point of occlusion. In our experience no significant ischemic manifestations were observed following such occlusion above the renal vessels for a maximum period of 45 minutes and below the renal vessels for a maximum period of 105 minutes.

The surgical approach to aneurysms located in the lower thoracic and upper abdominal part of the aorta is best provided by a left thoracotomy through the resected bed of the rib opposite the origin of the aneurysm with extension into the abdomen as a thoraco-abdominal approach if necessary. For aneurysms involving the abdominal aorta below the origin of the renal vessels, an abdominal approach is preferred using a midline incision extending from points well above and below the umbilicus.

The procedure of excision and replacement with aortic homograft has been done in 10 cases of aneurysms involving the lower thoracic and abdominal aorta with one death from progressive uremia and secondary hemorrhage in a 74 year old woman. Although further experience and longer follow-up observations are necessary for final evaluation, the gratifying early results obtained with this method of therapy lead us to believe that it is the most effective approach to the problem of aneurysms of the aorta.

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POSTOPERATIVE VASCULAR COMPLICATIONS*

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Without minimizing the importance of phlebothrombosis, thrombophlebitis and embolism in the role of postoperative vascular complications, it is the primary purpose of this paper to stress other types of vascular complications that may be equally catastrophic. It is the impression of the authors that very little interest and attention has been focused on the possibilities of postoperative vascular complications other than those associated with the venous system. It is also their opinion that the types of complications herein discussed are probably more frequent than the literature demonstrates (Table I).

Statistical information with reference to the true incidence of phlebothrombosis and thrombophlebitis is unreliable. Many cases are probably undetected, and conversely, many times a diagnosis of phlebothrombosis is made without sufficient supporting evidence. Identification of a positive Homan's sign as the only means of establishing a diagnosis may often be misleading.

Pulmonary embolism, certainly, should not be considered an exclusive surgical problem. The most sound approach is to consider any adult patient, confined to bed, as a potential candidate for thrombosis and embolism. Measures should always be in effect to minimize these possibilities. During an 18 month period, there were 23 cases of pulmonary emboli in the University Hospital. This represented 0.4 per cent of the total operations done, exclusive of neurosurgery, nose and throat, and gynecologic operations. Five postoperative deaths occurred from pulmonary emboli. If considered from the viewpoint of the total number of diagnosed emboli, the mortality becomes 21 per cent.

The majority of diagnosed cases of phlebothrombosis and thrombophlebitis were treated conservatively with anti-coagulation therapy and paravertebral procaine blocks. Ligation was reserved for the small group that demonstrated repeated emboli. No specific preventive measures were used except for stressing the importance of early diagnosis and prompt therapeutic intervention. In a small group of patients demonstrating obvious venous stasis, the lower extremities were supported by elastic bandages, postoperatively.

POSTOPERATIVE VASCULAR COMPLICATIONS SECONDARY TO TRAUMA WITH RETRACTORS

In attempting to obtain adequate exposure, particularly in the abdominal cavity, deep, sharp-bladed retractors may traumatize underlying structures. An obese person, undergoing a cholecystectomy, may become particularly susceptible to injury of the extra-hepatic structures. A thin person, upon whom an

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operative procedure is being done in either upper abdominal quadrant, may be equally susceptible to damage of the renal arteries. A Deaver or similar retractor may easily compress these vessels against the vertebral column, and produce either severance or a traumatic aneurysm.

Our attention was first focused on the problem when a bilateral lumbar sympathectomy was very promptly followed by the production of a thrombus of the major arterial vessels of the lower extremities, and subsequent death. Although this patient had advanced generalized atherosclerosis and hypertension, it is believed that prolonged compression of the iliac vessels during the operative procedure must be considered an incriminating factor.

TABLE I

Compilation of vascular complications

Case	Procedure	Complication
A. T.	Lumbar ganglionectomy	Thrombosis—right femoral and right common iliac arteries
M. H.	Cholecystectomy	Rupture of right renal artery
G. L.	Cholecystectomy followed by partial gastric resection	Hepatic artery aneurysm communicating with biliary tract
B. W.	Cholecystectomy	Atherosclerotic plaque occluding right brachial artery
A. L.	Incarcerated right femoral hernia	Embolic atheromatous plaque occluding superior mesenteric artery
W. W.	Right pneumonectomy	Propagating thrombus—right to left pulmonary artery
P. S.	Inadvertent injection of oil base medication into vascular system	Gangrene of digits of affected extremity
	Ligation of internal jugular veins in radical neck dissection	Increase of cerebrospinal fluid

ARTERIAL CATASTROPHES

Case 1. A. T., a 52 year old white man, was admitted to Baltimore City Hospitals on Sept. 4, 1952, complaining of extreme weakness, nervousness and leg *cramps*. Five years previously, he had had a *stroke* with left hemiplegia. There was subsequent recovery of function, except for residual weakness. For the past 5 to 6 years, he had noticed coldness of both feet and cramping of the legs. Conservative therapy had not resulted in amelioration of symptoms.

Findings. The blood pressure was 180/100. There were sclerotic and hypertensive eye ground changes. The heart was normal in size, rate and rhythm. There were hyperactive deep tendon reflexes on the left. There was left peripheral facial weakness. The lower extremities were cold and clammy. There were no trophic changes. The femoral pulse was present on the right; on the left, it was questionably present. The popliteal, dorsalis pedis and posterior tibial pulses were absent, bilaterally. The oscillometric index was zero for both popliteals. The electrocardiogram was normal. Temperature studies revealed organic obliterative disease with very moderate secondary vasospasm. Impression: severe, far advanced atherosclerosis obliterans of lower extremities, bilateral.

Course in hospital. Bilateral lumbar ganglionectomy, under spinal anesthesia, was performed on Sept. 23, 1952. During operation, a right lumbar vein was inadvertently torn in

the region of the medial-lumbocostal arch. Bleeding was controlled with silver clips. A transfusion of whole blood was given and the patient left the operating table in good condition. The entire bilateral procedure took two and one-quarter hours. Subsequently, it was shown that the site of the ganglionectomy on the right extended from L3 to L5, and on the left, also from L3 to L5. Because of the low type of ganglionectomy and troublesome bleeding, it is probable that prolonged pressure on the iliac vessels occurred. Unshod Deaver retractors were used to obtain exposure.

On the night following operation, he complained of considerable pain in the right thigh and leg. The following morning, his pulse rate was very rapid and he complained of severe pain in the right thigh with anesthesia and paralysis of the right leg below the knee. The right patellar reflex was absent; the left was present. Both achilles reflexes were absent. The right foot was cool, and the left foot was warm.

Pain developed in the left leg, and it was noted that the left femoral pulse was diminishing. The femoral pulse was absent on the right and the right leg below the knee became cadaveric in appearance. It was believed that the patient had an acute occlusion of his right femoral or iliac artery. Forty-eight hours postoperatively, it was noted that the patient had developed blotchy, cyanotic areas and coldness of the left leg, as well as of the right leg. He died about 50 hours postoperatively.

Postmortem examination revealed complete occlusion of right femoral artery due to a thrombus and complete occlusion of left common iliac due to a thrombus, both of which were new but antemortem; old thrombosis of left common iliac artery with recanalization and patency of internal and external iliacs on the left; nephrosclerosis; aortic stenosis; generalized arteriosclerosis; and postoperative bilateral lumbar ganglionectomy without evidence of retroperitoneal bleeding. The femoral veins were not thrombosed. There was an acute dilatation of the stomach. The cause of death was believed to be:

1. Acute dilatation of the stomach.
2. Thrombosis of right femoral and left common iliac arteries.

Additional cases illustrative of the possible association of retractors with postoperative vascular complications have also been noted.

Case 2. M. H., a 40 year old white woman, on hospital admission was complaining of epigastric pain. For a period of two years, she had been having recurring episodes of *indigestion*, nausea and vomiting. A diagnosis of cholelithiasis was confirmed by roentgenogram and several days after her admission, a cholecystectomy was done. The operative diagnosis was chronic cholecystitis with cholelithiasis. Nothing unusual was noted at the time of operation.

Course in hospital. The patient's postoperative convalescence was without event for a period of nine days, with the exception that she complained of persistent abdominal pain, not associated with objective findings. On the tenth postoperative day, she complained of excruciating abdominal pain, became shocked and died. The impression of the cause of death was *pulmonary embolism, postoperative*.

Postmortem examination. In the area of the right kidney, there was a large encapsulated oval mass, measuring 15 by 10 cm., and weighing 610 Gm., which included within it, the right kidney. Large quantities of clotted blood, involving most of the retroperitoneal space, were present. The largest portion of this clot was seen in the region of the right renal artery and along the right psoas muscle, and to a lesser extent, in the lesser peritoneal sac and the left upper quadrant. The clotted blood was soft and jelly-like, without organization. No evidence of bleeding was present in the region of the recent cholecystectomy. The right and left portions of the diaphragm were stained on both pleural and abdominal surfaces with blood. The estimated total quantity of free blood present was 3 litres. The abdominal aorta and inferior vena cava were dissected free, down to the iliac vessels. A stump of the right renal artery extended out 9 mm. from the aorta; 15 mm. distal to this stump, the renal artery was seen again, extending a distance of 35 mm. to the kidney pelvis. The

absent portion of the artery could not be detected. The proximal stump of the artery measured 10 mm. in diameter, and the saccular dilatation continued for a distance of 2½ cm. to within 1½ cm. of the kidney pelvis. The kidney, itself, appeared normal except that it was unusually soft and almost *mushy*. The hemorrhagic mass was between the kidney capsule and an outer capsule, which appeared to be composed of peritoneum and the posterior renal fascia. The dilated portion of the renal artery contained an organized blood clot completely occluding the lumen.

At the time the cholecystectomy was done, unshod Deaver retractors were used.

Case 3. G. E. L., a 31 year old white woman, was admitted to the University Hospital on Sept. 4, 1949 because of severe hematemesis and melena associated with upper abdominal pain. Three years previously a cholecystectomy had been done at another hospital. Prior to the cholecystectomy, there had been no history of gastrointestinal tract bleeding. Three months postcholecystectomy, right upper abdominal pain, associated with nausea and

TABLE II

Classification of hemorrhage related to diseases of the liver and biliary system (Lichtman 1936)

- A. Alcoholemic
  - 1. Portal in origin
    - a. Varices
    - b. Thrombosis of portal vein
  - 2. Hepatic in origin
    - a. Trauma
    - b. Yellow strophy
  - 3. Biliary tract in origin
    - a. Vascular
      - 1. Ruptured aneurysm
      - 2. Erosion of blood vessel
      - 3. Perforation of gallbladder
    - b. Hemorrhagic cholecystitis
    - c. Neoplasm with ulceration
- B. Cholemic dyscrasia

vomiting, returned. The attacks, which gradually increased in frequency, were identified with positive evidence of gastrointestinal bleeding. She was treated conservatively for a bleeding duodenal ulcer, except once, when, after recovery from shock, she was subjected to abdominal exploration with negative findings. The gastrointestinal hemorrhage continued, and the patient was transferred to the University Hospital.

At the time of admission, there was evidence of very active bleeding. After restoration of vascular equilibrium and recovery from shock, a partial gastrectomy was done, even though no active point of bleeding could be demonstrated at operation.

Course in hospital. On her fourth postoperative day, she again complained of upper abdominal pain, associated with evidence of gastrointestinal hemorrhage. Following repeated episodes, she died of massive hemorrhage.

Postmortem examination revealed an aneurysm of the hepatic artery which had perforated into the extra-hepatic ductal system.

Comment. Nauyn, in 1892, and Schmidt, in 1893, reported biliary tract hemorrhage. Kerr, in discussing the problem, was able to find less than 100 subsequent case reports on the subject. Lichtman classified hemorrhage due to diseases of the liver and biliary tract on an anatomical basis (Table II).

Massive bleeding from the biliary ducts has been reported due to stones, benign ulcer, rupture of hepatic artery aneurysm, erosion of the cystic, hepatic or portal vessels, and to cavernomatous transformation of the portal vein with rupture into the common duct.

Biliary hemorrhage associated with cholelithiasis is not infrequent, and Lichtman believes that there is evidence of gross hemorrhage in 1 to 5 per cent of all patients with gallbladder pathology. In discussing Kerr's report, Bigger described an aneurysm of the right hepatic artery intermittently rupturing into the right hepatic duct with great loss of blood into the gastrointestinal tract.

Dwight and associates have analyzed 92 cases of aneurysm of the hepatic artery reported in the literature. Trauma in the region of the liver had occurred in 7 cases. Three-fourths of the aneurysms were extrahepatic. In their report, it was stated that in the series of 92 cases, 30 aneurysms ruptured into the peritoneal cavity; 29 into the gallbladder or bile passages; 5 into the stomach or duodenum; 1 into the portal vein; 5 into the peritoneal cavity and 1 of the other sites. In 4 cases, posterior gastroenterostomy was done in the belief that bleeding was due to an ulcer. In 7 cases, surgery was directed to the gallbladder.

MASSIVE ARTERIAL OCCLUSION

Sudden arterial occlusion is a problem of extreme importance under any circumstance. With the changing population age factor, and an increase of the incidence of surgery in the aged, it is probable that sudden occlusive arterial phenomena will become increasingly important in the consideration of postoperative complications.

Case 4. B. W., an 89 year old white woman was admitted to the University Hospital because of persistent right upper quadrant pain. A diagnosis of cholecystitis and cholelithiasis was made.

Course in hospital. A cholecystectomy was done. Her postoperative course was uneventful for 10 days following which she experienced a sudden severe pain in the right shoulder which radiated into the right arm and hand. Examination revealed a cold, ischaemic extremity with collapsed superficial veins. The radial, ulnar and brachial artery pulsations were absent. The oscillometric index over the brachial artery was zero. Pulsations were noted at axillary artery level. A stellate block was done, using 1 per cent procaine. The block was associated with the development of a Horner's syndrome and a slight increase in skin temperature. However, there was no return of pulsations in the brachial artery and the oscillometric index remained zero.

Surgical exploration of the right brachial and axillary arteries revealed a complete obstruction of the brachial artery by a large atheromatous plaque. The artery was acutely angulated at the point of obstruction. Resection of the vessel was done with direct end to end anastomosis; a graft not being required. At the end of the operative procedure, pulsations could be felt distal to the anastomosis. The superficial veins filled, and the immediate postoperative oscillometric index was 0.5. Regional heparinization was done through a small intra-arterial polythene tube, inserted proximal to the point of anastomosis (fig. 1).

Postoperative follow-up. The radial pulse has remained normal in character during a five month follow-up period. Function of the extremity is excellent.

Case 5. A. L., an 84 year old white woman was admitted to the University Hospital on Nov. 18, 1951 with an incarcerated right femoral hernia of six days duration. Nausea, vomiting and obstipation had been present since the incarceration.

Course in hospital. After adequate intravenous hydration and upper alimentary decompression through a Levin tube, she was operated upon under sodium pentothal-curare anesthesia. Using the Henry approach, the lacunar ligament was incised and the incarcerated hernia reduced. The strangulated content proved to be a 5 cm. section of gangrenous ileum. Resection and lateral anastomosis were done and the wound was closed in a routine manner. On the second postoperative day, she suddenly showed signs of peripheral vascular collapse; became stuporous, and lapsed into coma. Notwithstanding resuscitative measures, death occurred four days after operation.

FIG. 1. Method of continuous heparinization following resection of the brachial artery and primary anastomosis.

Postmortem examination, which was confined to the abdomen, revealed gangrene of the entire small intestine due to an embolic atheromatous plaque wedged into the superior mesenteric artery 1.5 cm. from the aortic orifice.

In addition to sudden occlusive vascular phenomena, a propagating thrombus originating in the blind stump of a ligated vessel may be of serious consequence.

Case 6. W. W., a 42 year old white man was admitted to St. Joseph's Hospital with a diagnosis of carcinoma of the lung.

Course in hospital. A right pneumonectomy was done. His postoperative course was satisfactory for 48 hours. On the third postoperative day, he became progressively cyanotic and died.

Postmortem examination revealed a thrombus that had originated in the ligated stump of the right pulmonary artery and propagated into the left pulmonary artery.

CEREBROSPINAL FLUID PRESSURE AND INTERNAL JUGULAR VEIN LIGATION

Royster has recently emphasized the relationship between jugular vein pressure and cerebrospinal fluid pressure in the operation of radical neck dissection. He states that "although collateral channels begin their adaptation immediately after jugular ligation, the associated mechanical factors incident to operation

FIG. 2. Gangrene following intra-arterial injection of an oil base drug

produced a great temporary increase both in venous pressure (in the jugular) and in cerebrospinal fluid pressure. When both jugular veins are ligated at bilateral radical neck dissection, there is no doubt that the great increase in cerebrospinal fluid pressure is directly related to the shutting off of these veins. The suddenness of the production of the block imposes an immediate strain on the collateral channels which is added to and prolonged by the associated effects of anesthesia."

He states further that "ligation of one or both internal jugular veins may be followed by such a great increase in cerebrospinal fluid pressure that death will occur. The preoperative Queckenstedt test will show the response to compres-

sion of the neck veins. Although in itself inconclusive, a variation from the expected normal will indicate the need for following the spinal fluid changes at operation. In the case of a bilateral radical neck dissection in one stage, or the second stage of the same operation, a high venous and cerebrospinal fluid pressure will take place. It is necessary in these patients that lumbar puncture be done before operation, and continuous recordings of pressure in a manometer be made. When the pressure rises beyond the desired limit, fluid may be withdrawn and the pressure regulated as needed. There is no known level that must be

FIG. 3. Cross section of amputated finger showing fatty acid crystals in small arterioles

maintained, but if the pressure rapidly rises, the lowering should be done gradually, to prevent compression of the brain stem.

The symptoms of headache, vertigo, nausea or diplopia are relieved by the withdrawal of fluid, but will recur until the pressure returns to normal limits. In some patients undergoing radical neck dissection, the ligation of one internal jugular vein may be followed by a steep rise in pressure within the vein and the cerebrospinal space. Occasionally, death has occurred as an aftermath".

ARTERIAL THROMBOSIS FOLLOWING INJECTION OF OIL BASE DRUG

While not strictly a postoperative complication, it is believed that the following case merits inclusion in this series because it illustrates the serious consequence of inadvertently injecting a foreign substance into the circulating blood.

Case 7. P. S., a 27 year old white woman was admitted to the University Hospital on May 23, 1950 because of mental confusion and excruciating pain in the left arm and hand. At the time of her admission, she was 12 weeks pregnant, and because of a high anti-Rh titre, had been under the observation of the Rh laboratory. (A preceding pregnancy had resulted in the birth of an erythroblastotic baby.)

At 10 a.m. on the day of admission, she had received an intramuscular injection of an experimental drug which was being used in an attempt to reduce her circulating Rh anti-

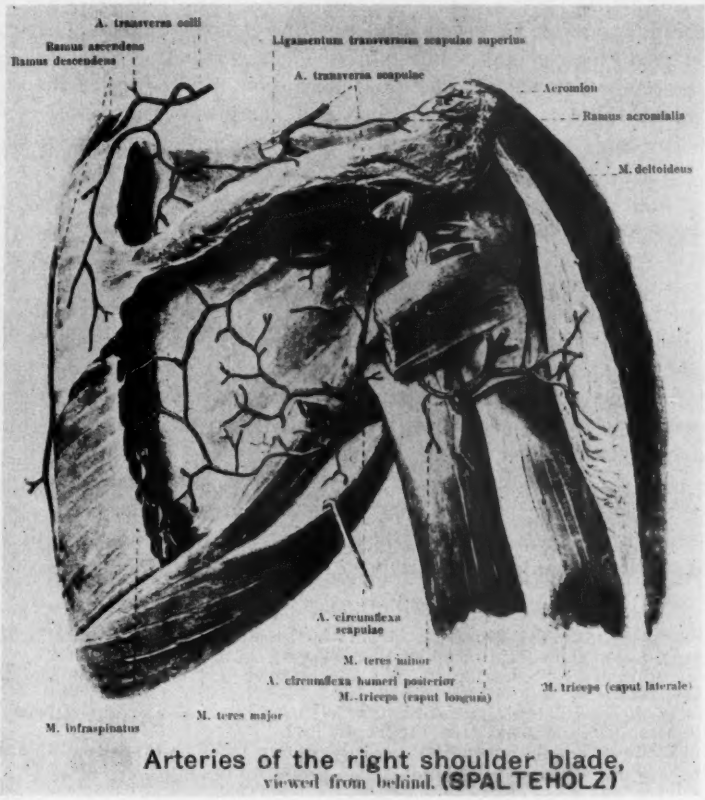

FIG. 4. Arteries of the right shoulder blade

bodies. The drug referred to, contained heptane-like fatty acids suspended in sesame oil. Shortly after the injection, the patient was found wandering about the hospital confused, disoriented and complaining of severe pain in the left upper extremity.

Examination of the left arm revealed a cold, pale and mottled extremity with the fingers rigidly fixed in flexion. The radial pulse was palpable. During a period of 72 hours, a progressive dry gangrene developed in the fingers of the left hand, notwithstanding rigorous therapy, which included repeated cervical sympathetic blocks, supplemented by the use of sympatholytic and anti-coagulant therapy (fig. 2). About two weeks after admission the little, ring, middle and index fingers were amputated at the metacarpophalangeal articulations. The thumb was amputated at the level of the interphalangeal joint. Further recovery was uneventful.

Pathological sections of the digits revealed intra-arterial crystal masses. Comparison of the outlines of these masses with C 17″ crystals obtained from an unopened ampule of the sesame oil suspension (166-P-54218) revealed microscopic similarity (fig. 3).

It is surmised that the injection needle punctured either a branch of, or the posterior circumflex humeral artery (fig. 4) in the deltoid region, and that the inadvertent injection of the oily solution into the arterial tree resulted in blockage of end digital vessels. There was associated disorientation and visual disturbance. It is possible that some of the solution entered the general circulation thereby producing cerebral manifestations. There were no permanent sequelae, from the cerebral viewpoint. The usual precaution of withdrawing the syringe plunger was taken at the time the injection was given. The viscosity of the solution probably prevented blood from being drawn back into the syringe.

SUMMARY

Without minimizing the potentialities and importance of phlebitis and embolism in the consideration of postoperative complications, other types of vascular complications are demonstrated.

In order to demonstrate this viewpoint, illustrative case reports are presented. These include (1) arterial thrombosis, (2) rupture of the renal artery, (both probably precipitated by damage from retractors), (3) gastrointestinal bleeding of hepatic origin (4 and 5), sudden arterial occlusion of a major vessel by embolic atheromatous plaques complicating postoperative convalescence, and (6) propagating arterial thrombus in a ligated vessel.

The hazard of inadvertent penetration of a blood vessel and injection of an oil base medication intended for subcutaneous or intramuscular use is stressed. In addition, attention is focused on the recent work of Royster relative to radical neck dissection and internal jugular vein ligation.

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AN EVALUATION OF THE MAES LEG AMPUTATION

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The problem of amputation of the leg in the presence of gangrene is one which has occupied the thoughts and investigative activities of surgeons for a long period of time. Questions concerning indications for amputation, site of amputation, optimum time of operation in relation to the duration and extent of the necrosis, and the effect upon these considerations of the type of gangrene, *wet* or *dry*, are still being asked. In view of the differing opinions, even of today, it is evident that final conclusions have not been reached.

In this presentation discussion is limited to amputations for non-traumatic gangrene of the foot and leg. During the past 25 years there has been a rather definite trend toward conservatism in the management of gangrene of the lower extremity associated with arteriosclerosis, diabetes, and thromboangiitis obliterans. In 1940, Williams and O'Kane[16] classified diabetic lesions of the lower extremity as those due to infection and decreased vascularity or mixtures of both. They recommended that the decision as to level and type of amputation be predicated upon the classification of the character of the necrosis: the more the vascular factor predominated, the higher and more radical the amputation should be. This differentiation in the extent of gangrene is thought to be very helpful in this respect. Prior to 1936, many writers, including Carter[2] and McKittrick,[7] advocated routine amputation of the leg above the knee for gangrene of the foot and leg, but since the report of Maes in 1931, there has been more and more interest manifest in the more conservative surgery of this condition. Beverly Smith,[14] in 1933, began to advocate amputation through the lower leg, using a technic very similar to that of Maes. In 1940, McKittrick[8] disagreed with Smith stating, "that in my hands it would lead to higher mortality, frequent reamputation, and prolonged hospital stay." However, McKittrick's mortality figures from 1923 to 1935 show an average of 11.3 per cent for thigh amputations contrasted with 1.4 per cent for leg amputations. But these figures are misleading, since no consistent effort was made to remove legs below the knee in his clinic, and the operation was undoubtedly reserved for those patients with minimal lesions. Bickel and Ghormley in 1943[1] reviewed their results of amputations below the knee. In a series of 103 cases, some of them bilateral amputations, 65 cases had primary operations below the knee with healing per primam; 17 with wound complications without reamputation, and 28 with reamputation above or below the knee. In 1942, Conway and Meigher[3] reported 46 cases of gangrene treated

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by amputation. Only five of these amputations were through the leg, but they were carefully selected and classified according to Williams' and O'Kane's classification. All five of the amputations were successful.

Veal and McFetridge[15] were among the early workers to advocate the wider use of leg amputation, believing that the Maes amputation was preferred, even though occasionally reamputation might be necessary, since the mortality risk was less than that of primary thigh section. Silbert[12] also has for many years promoted the leg amputation, though he early favored the Guillotine technic with traction to the skin and healing by granulation. In 1950, Silbert and Haimovici[13] reported mortality figures on amputations of the lower extremity for gan-

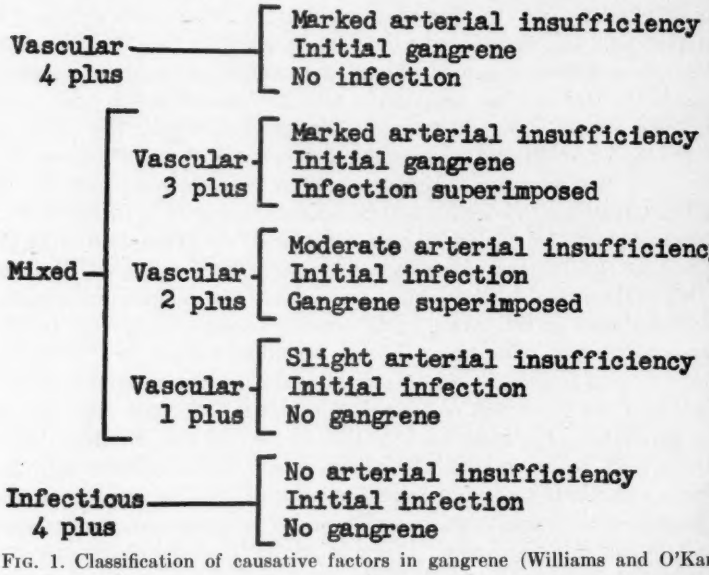

FIG. 1. Classification of causative factors in gangrene (Williams and O'Kane)

grene from 12 New York hospitals and from 11 hospitals from other cities. In 2,682 cases of primary thigh amputation, the mortality rate ranged from 10 to 60 per cent, the average being 27 per cent. In Silbert and Haimovici's own series of 172 cases of leg amputations, 50 of which were closed and the others Guillotine in type, a mortality rate of 9.3 per cent was recorded.

The question of drainage of the amputation stump has also undergone a change. Prior to the advent of antibiotics, most surgeons routinely drained all amputation wounds. Mandelberg and Sheinfeld[6] stated in 1946 that "the number of leg cases subjected to closed amputation are too few for deductions, but the trend is the same as in thigh amputation. Primary union and lack of gross infection are more likely in undrained cases." These authors discussed 128 cases.

THE MAES OPERATION

The Maes technic for amputation through the leg is quite simple (fig. 2). A circular incision is made through the skin at a level about 5 cm. below the planned

site of the amputation stump. The skin is allowed to retract, and the fascia of the leg is incised. This fascia is in turn allowed to retract, and the muscles are divided down to the bones. This is the old *en saucisson* method of the French. The tibia is then sectioned; the tibial crest beveled and the bone is smoothed with a rasp. The fibula is cut from 3 to 5 cm. above the level of the severed end of the tibia. Bleeding is controlled with a minimum quantity of fine catgut. The stump is closed in a single layer in an anteroposterior direction using through and through

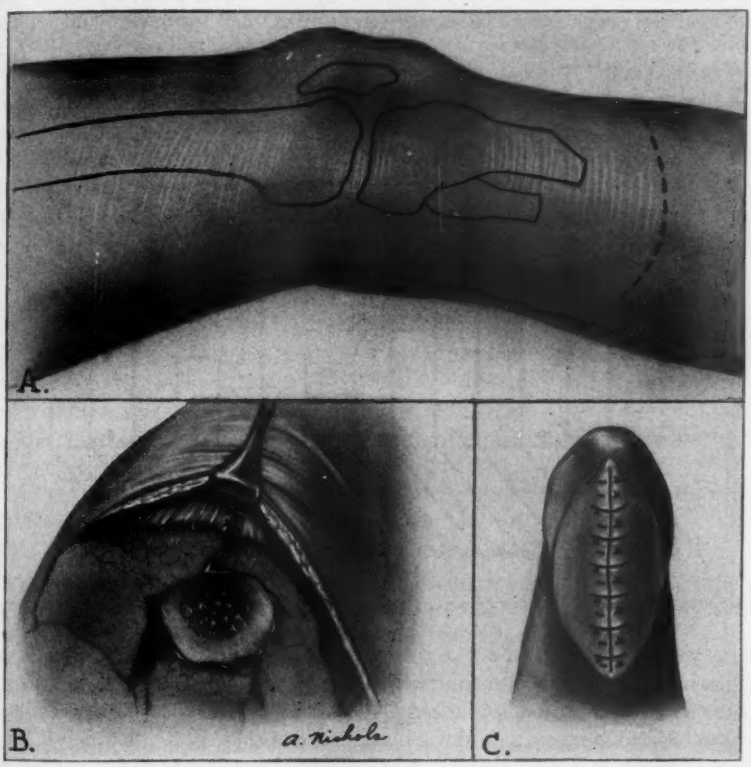

FIG. 2. A modification of Maes' method of leg amputation

sutures of heavy silk. This type of deep through and through suture not only approximates the skin but also the muscles and obliterates any potential dead space where blood or serum may collect. A few more interrupted silk skin sutures are usually desirable to more accurately approximate the skin edges. A fluffed gauze dressing is then applied to the wound. No traction is used on the skin. In a few instances, a posterior molded splint has been employed to minimize possible flexion contractures. The dressing is changed on the second postoperative day and the flaps are inspected and palpated for crepitus, and the odor, if any, of the wound is noted. After redressing, the stump is left undisturbed until time

for removal of sutures, unless the patient manifests systemic evidence of infection.

RESULTS

The results of the Maes type of procedure in the University of Kansas and the Kansas City Veterans Administration Hospitals are shown graphically in fig. 3 The over-all mortality rate of this short series of 17 cases is 11.3 per cent which compares favorably with those of other surgeons employing comparable procedures, and is considerably below the figure mentioned by Silbert and Haimo-

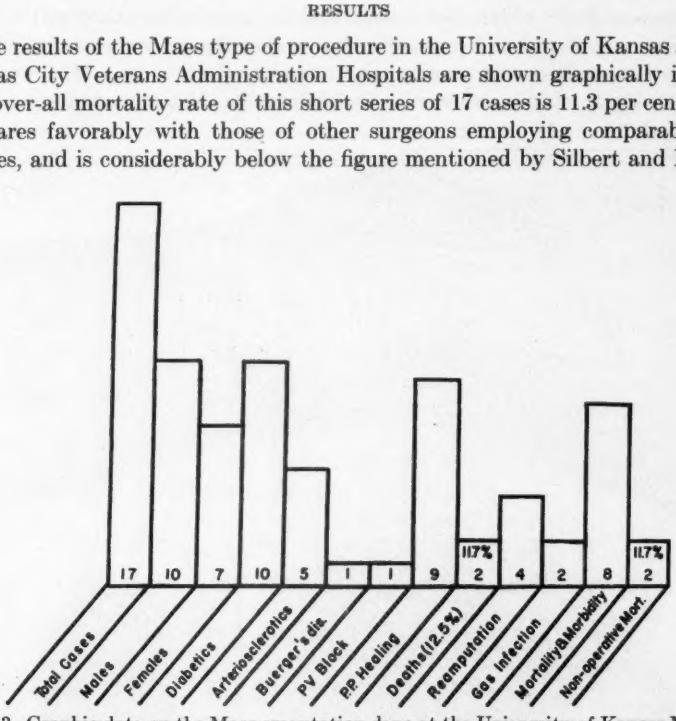

FIG. 3. Graphic data on the Maes amputation done at the University of Kansas Medical Center and the Kansas City Veterans Administration Hospital.

vici for thigh amputation. Nine of the cases had per primam healing; 2 had a gas bacillus infection requiring reamputation, and 4 developed slough and infection which was treated by reamputation. One patient died of a cardiovascular accident, and 1 died of mesenteric thrombosis. None of these patients was treated by sympathectomy, and only 1 had a paravertebral block. Only 5 of the series had pure arteriosclerosis without diabetes, and 1 had Buerger's disease.

COMMENT

The greatest apparent advantage of the Maes technic of amputation for diseases involving impairment of circulation lies in the preservation of what blood supply is present to produce a satisfactory amputation below the knee. The absence of buried suture material minimizes tissue strangulation, and anteroposterior closure permits edge approximation without construction of long flaps.

Our experience with sympathectomy is too limited to have an opinion concerning its value. There is published evidence to show that sympathectomy may play

an important role in the management of peripheral vascular disease. DeBakey, Creech and Woodhall,[4] in 1950, recorded a series of 146 cases of arteriosclerotic peripheral vascular disease, 55 of which were bilateral, which were subjected to sympathectomy. Of those patients who had no gangrene, 85 per cent were improved. Of those with impending gangrene, 75 per cent were improved, and of those in whom frank gangrene was present, 35 per cent were improved with salvage of the extremity. When considering gangrene on a predominantly vascular basis, these figures appear to be quite significant. Ochsner[9] doubts the value of paravertebral block in peripheral vascular disease since the response of the diseased vessels to block of the nerve pathways would be too slow for clinical benefit to be derived. However, lack of response to a block, in his opinion, does not mean the patient would not be improved by sympathectomy, due to its more permanent nature. Recurrence of vasoconstrictor activity following sympathetic denervation is reported by Robertson and Smithwick.[10] In the lower extremities which they studied, 85 per cent showed complete denervation at the end of the first year, but of these a third showed evidence of return of function in the 1 to 5 or the 5 to 15 year follow-up. What effect this phenomenon will have on the long term results of sympathectomy is not yet known.

CONCLUSIONS

It is emphasized that the Maes operation is not considered a panacea for the treatment of gangrene of the lower extremity. However, it is believed that there is merit in the procedure, and that this type of lower leg amputation will permit a greater percentage of successful *below the knee* amputations than any other technic.

The technic of the Maes' amputation disturbs the blood supply to the stump less than other technics.

From the standpoint of function, the leg amputation is much superior to the thigh amputation and should be used when there is any hope of success.

There are published statistics to prove that the mortality rate of amputation below the knee is much less than amputation through the thigh.

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APPENDICITIS: TRENDS IN MANAGEMENT

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The purpose of this paper is an effort to study the trends in management of appendicitis up to the present time. Appendicitis, as a clinical entity, was first described by Reginald Fitz in 1886. His paper gave to the profession for the first time means to recognize appendicitis and to differentiate it from other acute syndromes, and led to a controversy as to the proper method of treatment that lasted for years. Although Fitz in his original paper advocated early removal of the diseased appendix, there was a lapse of some 10 to 15 years before this principle became generally accepted.

It is interesting to follow the development of the attitude of the profession towards therapy and the mortality rate of appendicitis through the years. Because of the tremendous number of articles appearing in the literature, it is obviously impossible to summarize them all. Thus, several articles appearing around 1900 and others close to 1925 were selected at random. The interest manifested by the medical profession in appendicitis is illustrated by the statement of Bernays in 1903 that over 2000 articles had previously appeared in the literature of Europe and America.

In general, the therapy in 1900 could be divided into surgical and conservative. The surgical therapy might be either early, late or interval operation. Fitz, in 1886, reported a mortality rate of 26 per cent. Samuel Lloyd in 1900, reported comparable mortality rates of 24 per cent in his cases treated conservatively. The reduction in mortality rate that could be obtained by early operation played an important part in some of these early studies. This is illustrated in the statistics quoted by Lett in 1905. His series had a mortality rate of 1.2 per cent for those patients operated upon the first day; 3.0 per cent on second day; 8.7 per cent on third day; 4 per cent on fourth day; 5.4 per cent on fifth day and later. The over-all mortality rate was 17 per cent. At that time, the difficulties of diagnosis were known as well as were the varying clinical manifestations. Lockwood in 1902 stated that he knew of no disease which was so treacherous. He continued by discussing pelvic appendicitis and the conditions in which the appendix produces pain in the right flank and the gallbladder region. He then completed his discussion by writing that at the onset, and afterwards, the pain of appendicitis may be referred to any part of the abdomen. During that same period, studies were being published advocating interval removal of the appendix. This may be illustrated by the paper of Samuel Lloyd, Professor of Surgery, New York Post Graduate School, published in 1900. He reported a follow-up of 25 cases that recovered with conservative treatment. Eighteen of the 25 had recurrent attacks. Thirty-three years later Royster stated that 98 per cent of

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the patients who had a definite attack of acute appendicitis would have subsequent attacks.

The picture had changed by 1925. The treatment of choice was early appendectomy. Unusual manifestations were often presented to explain the position of the appendix or its pathologic state. An editorial appearing in the Journal of the American Medical Association at that time, emphasized the fallacy of a high white cell count in reaching a diagnosis. The use of drains and the type of incision came in for considerable discussion. Short preferred a Battle incision with a stab wound for drainage. The McBurney incision was probably the most popular. This was due to the lower percentage of incisional hernias that followed infected wounds with the McBurney incision. Surgeons had learned that it was better to drain and leave the ruptured appendix in the abdomen than to produce a generalized peritonitis by searching for it. Selman emphasized the advantage of light gas-oxygen anesthesia with novocaine infiltration in severely ill patients.

With the improvements in therapy, too numerous to mention, there was a drop in the mortality rate. Short in 1925, reported that the over-all mortality rate was 6 per cent and of those operated upon in the first 24 hours it was 0.5 per cent. His own mortality rate in 39 cases operated upon during the first day was nil. By that time, 1925, or possibly a few years earlier, early removal of the appendix had become unequivocally accepted as the treatment of choice. It must be recognized that these changes occurred gradually and an exact time of change does not exist.

The problem then became that of educating the lay public to call a physician soon after the onset of abdominal pain, and not to take a purgative. In Atlanta, a pamphlet on this subject written by Dr. Frank K. Boland, Sr., was published by subscription from doctors throughout Georgia for distribution to the lay public. Similar efforts occurred in other parts of the country.

It is my opinion that efforts along these lines have been a tremendous factor in the reduction of the over-all mortality rate from appendicitis. This policy of education must continue, however, because occasional late cases particularly from the rural areas are still being seen. In general, the lay public at the present time has become so aware of the dangers of a perforated appendix that it is seldom indeed that the need of an operation is questioned by a patient when told that he has appendicitis. This has led to a situation in which the physician may be called upon to make a diagnosis early in the disease before localizing signs have become definite. A physician, finding himself in such a situation, with full knowledge of the treacherous nature of the disease and the possible disastrous consequences of delay, may often be tempted to operate because operation is the simplest and safest answer. This attitude may result in other conditions producing pain in the right lower quadrant being overlooked.

In the series here presented all cases in which the appendix was removed during two separate six month periods in two Atlanta hospitals were studied to determine the trends in present day management of appendicitis. In hospital A, a 475 bed general hospital, the period from January to July 1951 was used. The period from July to December 1949 was used in hospital B, also a general hospital

of 450 beds. Both hospitals are used entirely by physicians in full-time practice; are not associated with a medical school, but have active residency training programs. During these two periods, there were 642 cases in which the appendix was removed. In 170 cases, or 26.4 per cent, the appendectomy was incidental to other operations and in 472 cases, or 73.63 per cent, the appendix was the pri-

TABLE I

Those cases with an admission or preoperative diagnosis of acute appendicitis

Pathological Report	No. Cases	Per cent
Acute suppurative	110	30.13
Acute suppurative with fecalith	8	2.19
Acute appendicitis	48	13.15
Acute appendicitis with fecalith	1	.27
Acute gangrenous	16	4.38
Acute gangrenous with fecalith	5	1.36
Subsiding appendicitis	25	6.84
Subacute appendicitis	1	.27
Perforated	5	1.36
Oxyuresis appendicitis	5	1.36
Diverticuloses with subsiding appendicitis	1	.27
Diverticuloses with fecalith	1	.27
Acute catarrhal appendicitis	10	2.73
Chronic periappendicitis	2	.54
Acute periappendicitis	2	.54
Obliterative fibroses	13	3.56
Chronic reactive lymphadenitis	2	.54
Ca. cecum with ac. gangrenous appendix	1	.27
Intussusception with acute appendicitis inside cecum	1	.27
Mucocele of appendix	2	.54
Ruptured ovarian cyst and involution appendix 1; obliterating fibroses 2; subacute 1; subsiding 2	6	1.64
Ruptured corpus leuteum involution 3	3	.82
Acute salpingitis involution 2	2	.54
Mesenteric adenitis involution 3	3	.82
Ureteral calculus involution 1	1	.27
Exploratory for abdominal pain involution 3	3	.82
Involution	81	22.19
Involution with fecalith	1	.27
No path. report	6	1.64
Total	365	

mary reason for operation. The average age of patients was 29 years, the youngest being 3 and the oldest 77 years old. The ratio of males to females is approximately the same with males slightly in predominance. The McBurney incision was by far the incision of choice in those cases treated by appendectomy only. The incidence was as follows: McBurney incision was used in 283 patients or 59.95 per cent; right rectus incision in 76, or 16.1 per cent; transverse incision in 18, or 3.81 per cent. Ninety-four or 24.12 per cent, of the charts did not record

the type of incision used. The stump was inverted in 228 cases, or 48.30 per cent, not inverted in 161 cases or 34.11 per cent, and not recorded in 82 cases, or 17.58 per cent.

No effort has been made in this paper to study the laboratory data. It was noted that only 14 or 3.83 per cent of the patients of the 365 with an admission or preoperative diagnosis of acute appendicitis, had a white cell count below

TABLE II

Those cases with preoperative or admission diagnoses other than acute appendicitis

Preoperative or Admission Diagnoses	Pathological Report											
	Acute Cat.		Inv.		Obli. Fibrosis		Subsiding		Subacute		Chronic	
	#	%	#	%	#	%	#	%	#	%	#	%
Chronic	0	0	27	72.97	5	13.51	5	13.51	0		0	
Subacute	0	0	17	58.62	2	6.89	8	27.58	1	3.44	1	3.44
Recurrent and chr. recurrent	0		18	72.00	5	20.00	2	8.0	0		0	
Interval	0		4	57.14	2	28.57	1	14.28	0		0	
Subsiding	1	11.11	0		0		0		0		0	
Total	1		70		18		16		1		1	

TABLE III

Incidental appendices removed during operations for other diseases

Pathologic Diagnoses	No. Cases	Per cent
Involution	122	71.76
Subsiding	8	4.70
Subsiding melanoses	1	.58
Chronic periappendicitis	1	.58
Hyperplasia lymphoid tissue	1	.58
Acute appendicitis	1	.58
Obliterating fibroses	29	17.05
No pathologic report	7	4.11
Total	170	

10,000 per cu. mm. Table I compares the admission diagnosis with the pathologic diagnosis in the 365 cases with a preoperative or an admission diagnosis of acute appendicitis. In this table, a multiplicity of pathologic diagnoses makes any effort at comparison difficult, particularly since there exist so many different opinions as to just which pathologic picture caused clinical symptoms.

The following diagnoses as obtained from the pathologists' reports are given as briefly as possible and with an effort to avoid detail. These diagnoses will vary in detail from institution to institution. The routine in use in both hospitals is a study of three separate sections from each appendix.

PATHOLOGICAL DIAGNOSES

1. Acute. Mucosal ulceration, muscular infiltration by neutrophils.
2. Acute catarrhal. Intact mucosa, neutrophils in lumen, hypersecretion by goblet cells, early submucosal infiltration with polymorphonuclear cells.
3. Acute suppurative. Same as acute with fibrinous exudate on serosa.
4. Acute gangrenous. Same as acute with grangrenous changes in the muscle.
5. Subsiding. Edema of the muscular coat with a sprinkling of eosinophils in the muscle. Intact mucosa and serosa.
6. Subacute. Mucosal ulcerations with neutrophils and eosinophils and possibly a few lymphocytic cells in submucosa and muscular layers.
7. Obliterative fibrosis. Lumen closed witn fibrous tissue. No inflammatory cells.
8. Chronic reactive lymphadenitis. Large germinal centers with focal necrosis in the germinal centers.
9. Involution. Normal, taking into consideration the normal involution of lymphatic tissue with age.

Table II gives the results of the break-down of those cases other than acute, and Table III lists the incidental appendices.

There were no deaths in this series.

DISCUSSION

This study was undertaken to determine the present trends in the management of appendicitis. The number of cases involved are not large enough to be of any statistical value in studying the various clinical pictures produced by the acutely inflamed appendix. However, certain trends in the management of appendicitis may be deduced. The tremendous improvement in anesthetics, and the discovery and widespread use of antibiotics have played an important role in the reduction of the over-all mortality. The education of the lay public to call a doctor as soon as a stomachache develops and to take no laxative, has also been an important factor.

Those cases in which the surgeon had made a preoperative diagnosis of actue appendicitis are broken down in Table I. From this table it may be seen that 22.19 per cent of the appendices removed were normal. In a second small group (4.9 per cent) though the appendix was considered normal by the pathologist, some other acute condition requiring surgical treatment was discovered at operation. A third group may be separated in which the relation of what was found at operation to the clinical picture was debatable. Examples of this may be seen as obliterated fibrosis, subsiding appendicitis, and a normal appendix with fecalith. Five cases that had ruptured before admission recovered. These percentages compare favorably with those from other parts of the country, considering variations in the manner of reporting.

In Table II are recorded the cases in which the surgeon was not sure that he was dealing with an acute process. A comparison of the clinical diagnosis with the pathologic report in Table II reveals no correlation. No comparison is pos-

sible in the groups with diagnoses of interval or recurrent appendicitis. The patient who recovers from a previous attack of appendicitis is likely to have another, therefore, his appendix probably should be removed in the interval between attacks. Most experienced physicians have observed an occasional patient who has been relieved of recurrent, vague, abdominal discomfort following appendectomy. It should be emphasized that these cases are few and the vast majority of such patients are not relieved. From clinical experience, it seems probable that a rare condition of the appendix may exist, with no relation to the pathologic status, that may on occasion produce clinical symptoms.

Table III lists the appendices removed incidental to operative procedures not directed primarily at the appendix. The word appendicitis in any form was not listed in the preoperative diagnoses.

A comparison of the pathologic reports in Tables II and III shows a high correlation. This is a higher correlation than that found when the pathologic diagnoses are compared with the clinical diagnoses in Table II. To be taken into consideration also in this comparison, are a large number of conditions other than appendicitis, that may cause right lower quadrant pain. Patton, in studying ovarian pain, reported that 79.5 per cent of the women in his series, who had been operated upon for chronic appendicitis, still had pain. Since the correlation between the clinical diagnosis and the pathologic picture is so low and the results of operation so relatively poor, every patient except acute cases should have a complete roentgenologic, laboratory and clinical work-up before his appendix is removed.

SUMMARY

Throughout the past few years, the mortality rate of appendicitis has been greatly reduced. An unruptured appendix can be removed safely. The separation of appendicitis as a clinical entity from other abdominal conditions and the progress in management of its acute phases has been one of the great triumphs of American medicine. Notwithstanding the tremendous improvements, the situation is still far from perfect, and if one could be so bold as to make a plea for the future it would be for *more complete utilization of laboratory facilities and pathologic knowledge in further reducing the mortality and morbidity in appendicitis*, and in *avoiding unnecessary operations*.

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BENIGN GIANT CELL TUMOR OF BONE

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In each instance that a benign giant-cell tumor is presented to our Tumor Board for disposition, in addition to the usual disagreement regarding therapy, many questions arise that are pertinent to the solution of this problem. There are such questions as *what are the characteristics of giant-cell tumor and how is the differential diagnosis made? Where and how does irradiation or surgery produce its effect? What are the characteristic roentgenographic changes that indicate healing or recurrence, and what is the ultimate appearance of the healed lesion?* The character and incidence of malignant change is always a controversial subject. A review of the literature shows constant progress in the solution of problems posed but disagreement persists, especially regarding surgery versus roentgenotherapy.

Nature of Benign Giant-cell Tumor. Noteworthy progress has been made in the past 20 years by such men as Geschickter and Copeland[5], Jaffe and Lichtenstein[6] and Coley[2] in defining the bona fide giant-cell tumor. The *myeloid tumor* of Paget and the *brown tumor* of hyperparathyroidism have been discarded. The so-called *variants* have been separated and classified. These include the chondromatous giant-cell tumor described by Codman, the spindle-cell, or the healing or xanthic *variant*, now called *non-osteogenic fibroma of bone* and the atypical, subperiosteal giant-cell tumor in unusual locations, delineated by Jaffe and Lichtenstein as *aneurysmal bone cyst*. The chondromatous giant-cell tumor is now designated as chondroblastoma. The exact relationship of benign bone cyst to tumor is still disputed. Geschickter, for example, considers it a *variant* of giant-cell tumor. The differentiation of bone cyst by roentgenogram may be difficult.

Benign giant-cell tumor is not a frequent tumor. Forty-one cases were seen in the Campbell Clinic[9] in a period of 20 years. Sir Harry Platt[8] states that these tumors are seen in England on the average of one a year for each hospital. Giant cell tumors occur most frequently in early adulthood, with the highest incidence in the third decade. Bone cysts are more common in younger persons. The majority of tumors are found in the distal end of the femur, proximal end of the tibia, distal portion of the radius and proximal portion of the humerus. In Coley's series, 66 of 124 tumors occurred around the knee. According to Geschickter and Copeland, the tumor occurs only in bones which have been formed from cartilage.

Symptoms. These are usually noticed 6 to 24 months before the patient consults a physician. The clinical history has a sequence of trauma, pain and tumor. Pathological fracture has been noted in about 14 per cent of the cases.

Roentgenographic Appearance. The picture is that of a circumscribed osteolytic process eccentrically placed in the epiphysis of a long bone. The cortex over

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the tumor is thinned and expanded. The thin, bony shell is often perforated and fractured. Trabeculations divide the mass into compartments. The tumor does not invade the articular cartilage. There is no periosteal reaction unless fracture has occurred.

The differential diagnosis is often difficult. Osteolytic osteogenic sarcoma, solitary myeloma, chondroma, hyperparathyroidism with cystic lesion and benign cysts all show similar characteristics.

Pathology. 1. Gross. Wet tissue has the appearance of an old bruise. There is necrosis, cystic degeneration and large blood spaces. The color is produced by degenerated blood pigment.

2. Microscopic. The benign lesions show multiple giant-cells in a mass of smaller round or spindle-cells. Giant cells average 30 per field with 15 to 200 nuclei. The network of stroma and giant-cells is surrounded by blood filled spaces.

Willis[10] points out that there is no sharp separation between innocent and malignant tumors. He states, "The truth is that these tumors show a range of structures and behavior and that a few, not initially distinguishable from their benign fellows, invade and metastasize." Ellis[4] agrees that *the suspected tumor has been malignant from the beginning*. The only cases to be accepted as showing malignant changes are those that had preliminary biopsy, because clinical and roentgenographic appearances alone cannot be relied upon. Russell believes there are two-forms of malignant giant-cell tumors. In one, *the lesion remains essentially a giant cell tumor* and in the other form, *the stroma cells undergo metaplasia and the tumor is indistinguishable from osteogenic sarcoma*. Jaffe and Lichenstein[7] recommend division into three grades, based upon the activity of the stromal cells. They admit that "no method of appraising potential aggressiveness from cytological criteria is infallible." The percentage of cases showing malignant change are variously reported to be from 5 to 10 per cent.

Treatment. There is no agreement as to whether treatment should be by irradiation or surgery. Amputation has been discarded except for established malignant changes or when earlier conservative measures have yielded such an unsatisfactory functional result that substitution of an artificial limb seems advisable.

Generally irradiation is recommended for tumors in inaccessible regions (spine and upper femur), and surgery for accessible lesions (ribs, fibula, etc.). Sir Stanford Cade states, however, "one curious belief should be exposed, namely that accessible tumors should be treated by surgery and inaccessible tumors by irraradiation. If irradiation is successful in inaccessible tumors, why should it be denied patients with accessible and superficial lesions?" Cutler[3], Buschke, Cantrell[1] and others prefer irradiation because it respects capsule of tumor; eliminates danger of infection; has less unfavorable effect upon function; possesses at least as high a cure rate as surgery and entails no more prolonged period of disability than does surgery. Coley finds this view misleading and states, "It is our opinion that the profession in general is seldom made aware of irradiation failures or the late unfavorable sequellae." Geschickter believes that irradiation is far slower in its effect and disables the patient too long. One cannot dismiss the excellent results obtained by irradiation by numerous authors.

Irradiation methods. Details of technic will not be given in this paper. There are two general methods: (1) repeated small doses in single or multiple series, (2) single course of intensive therapy.

Post-operative roentgenotherapy. Such treatment is generally not routinely recommended unless there is evident recurrence following operation. Geschickter and others recommend repeated curettage until cure has been obtained. That post-operative roentgenotherapy will effect cures in these cases is noted in several reported series. The problem of further therapy in the irradiation failure case is great. Surgery following adequate irradiation may be hazardous because of danger of infection and failure of tissue healing. Amputation may be necessary. One is impressed by reports that in the malignant cases, a combination of operation and irradiation has been used. One also notes that such cases have had large doses of roentgenotherapy. It is, however, entirely logical that the suspected tumor had been malignant from the beginning and therefore the reason for failure of the therapy.

Roentgen ray changes produced by surgery or irradiation. Small, and even large areas of reduced density may persist after operation. The roentgenogram may not differ greatly from those obtained prior to operation. A persistent alteration of the bony trabeculation is seen. The important point is not the persistence of reduced density but the question of further bone destruction. Where there is an increased osteolysis, an active process must be suspected.

Following roentgenotherapy a paradox reaction may occur where there appears to be increase in tumor, *more destruction, increased pain, heat and swelling.* This occurs immediately following a course of therapy (it is quite marked where intensive therapy is employed) and lasts about six to eight weeks. When reossification begins it proceeds continuously, but not until one to two years later may one expect a complete cure. Here again a normal bone architecture is not formed. Strong, irregular bone formation fills up the cavity of the tumor. When reossification begins, intervals between treatments may be prolonged or even discontinued if there is indication that cure can proceed without further roentgenotherapy. A cure should be attempted with the minimal amount of irradiation.

REPORT OF CASES

Case 1. This 48 year old white farmer was admitted to the Veterans Hospital on Aug. 28, 1938. Onset of dull aching pain and swelling of upper end of left tibia was noted about six years prior to admission. There was no history of trauma. In December 1935 a diagnosis of giant-cell tumor was made and the lesion was curetted at the Veterans Hospital, Columbia, South Carolina. A cast was applied for four months and then the patient was given crutches. The pain gradually recurred and the tumor increased in size.

Examination showed limitation of motion at the knee. Expansion of the upper end of the tibia was noted. Roentgenogram showed a typical giant-cell tumor (fig. 1, Case 1). After review of the slides a giant-cell tumor was reported, slightly active but benign.

Treatment consisted of roentgenotherapy from Dec. 27, 1938 to Jan. 13, 1939. Anterior and posterior and two lateral ports were used. Factors 10 by 10 cm. port, 220 KV, 25 MA, ½ cm. + .A1 and 50 cm. distance, 100 r daily for a total of 400 r to each port. The patient was readmitted November 1939. There had been less pain and discomfort. Minimal roentgenographic improvement was noted. Roentgenotherapy similar to the above was adminis-

FIG. 1. Case 1. Roentgenogram showing giant-cell tumor of bone

FIG. 2. Case 1. Roentgenogram taken prior to amputation

tered from Nov. 18 to Dec. 6, 1939. He was readmitted in August 1940. He then complained of a dull ache. He had continued to use his crutches. The limitation of motion of his knee was unchanged. Roentgenogram showed very little change in the lesion. Roentgenotherapy was repeated as above from Aug. 18 to Sept. 12, 1940. He was again admitted in September 1941. Review of roentgenograms indicated continued improvement. Four treatments of 200 r each were given. He entered the hospital again in September 1943. Patient stated he

FIG. 3. Case 2. Roentgenogram showing appearance of tumor prior to roentgenotherapy

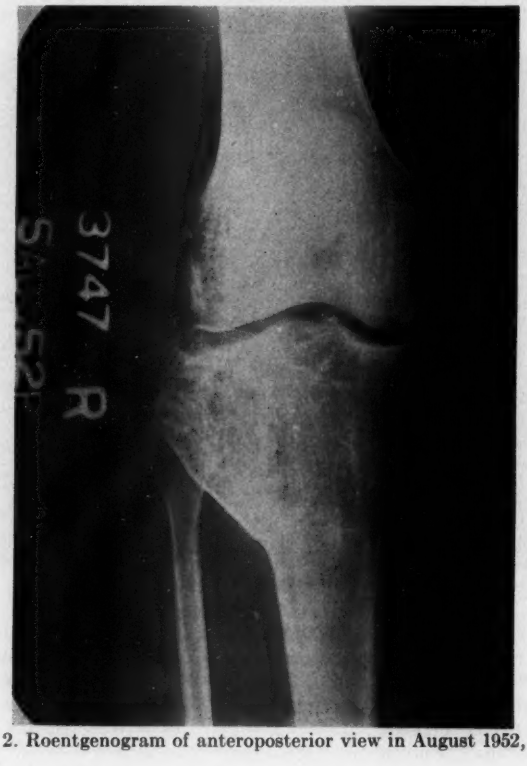

FIG. 4. Case 2. Roentgenogram of anteroposterior view in August 1952, five years after initial therapy.

could walk without crutches but felt more secure with them. No significant change was noted on roentgenographic study. He returned to the hospital again in August 1944. A review of all roentgenograms indicated very little change in the appearance of the lesion. Readmission in July 1947. Roentgenograms again showed no change.

In May 1952 (fig. 2), an amputation was necessary because of breakdown of irradiated skin over the upper tibia with extension of infection into bone, producing an osteomyelitis. Pathologic examination of specimen revealed osteomyelitis but no tumor in any of the sections.

FIG. 5. Case 3. Roentgenogram of anteroposterior view prior to treatment on April 17, 1950.

CONCLUSIONS

1. Apparently roentgenotherapy had eradicated the disease. The persistent cystic changes were mistakenly interpreted as residual disease and resulted in repeated needless roentgenotherapy, producing skin damage that ultimately broke down.

2. Despite a combination of surgery and repeated roentgenotherapy, no malignancy was found or produced.

3. We wonder whether this man, despite the limitation of motion at the joint,

was not more active and useful than he would have been with amputation and an artificial limb.

Case 2. This 23 year old veteran was admitted to the hospital on April 22, 1947 with a history of intermittent pain of his right knee of one year's duration. Examination showed a tumor of the upper tibia. Roentgenographic diagnosis (fig. 3), was confirmed by biopsy. Treatment consisted of 2300 r, divided between anterior and posterior ports; 100 r were given daily. Factors were as in case 1.

FIG. 6. Case 3. Roentgenogram showing results following roentgenotherapy

Repeated follow-up examinations at three month intervals reveal a well functioning knee without pain or discomfort. Moderate expansion of the lateral condyle has persisted. The plateau remains intact. Small cystic areas persist without change (fig. 4).

Discussion. 1. Follow-up of about five years shows excellent functional and roentgenographic result.

2. Single course of small daily and total dose was used.

Case 3. This 41 year old man was admitted to the hospital on April 13, 1950. Four years ago, following wrenching of his left knee, swelling and pain developed. This subsided some, but never completely. Following another injury six months ago, he again developed pain

and swelling. He was admitted to the Veterans Hospital, Coral Gables, Florida, where a biopsy was done and reported to be a giant-cell tumor. He was transferred to our hospital for appropriate treatment.

Examination revealed a man with a decided limp. Definite enlargement of the lateral condyle of the left femur was noted (fig. 5). Treatment with roentgenotherapy from Apr. 17, 1950 to May 18, 1950, 1200 r to anterior and posterior ports, 100 r given daily. Patient was discharged on May 18 with ischial weight bearing brace.

FIG. 7. Case 4. Roentgenogram of anteroposterior view prior to therapy

Follow-up roentgenograms revealed continued improvement. Last roentgenogram was July 1952 (fig. 6), which showed increased sclerosis and improved trabecular pattern throughout the area of previous involvement. Several small lucent areas remain. Patient has discarded his prosthesis and is without pain.

Discussion. 1. Excellent result has been obtained with single series of roentgenotherapy; daily and total doses were small.

2. Results from such therapy are slow. One must be patient and not change type of therapy or repeat therapy if results are not as rapid as patient or patient's physician thinks it should be.

Case 4. This 48 year old white man was admitted to the hospital in August 1950. Patient had a seven year history of intermittent pain, tenderness and swelling of the left knee that followed an injury. Episodes of swelling and tenderness occurred at first at about six month intervals. Prior to admission there was severe pain on motion and weight bearing for six months. Biopsy at the Veterans Hospital, Coral Gables, confirmed diagnosis.

Examination revealed firm, diffuse swelling of the upper end of the left tibia (fig. 7).

Treatment: Roentgenotherapy, 1000 r to anterior and posterior ports, 100 r to one port daily. Readmitted in January 1951 because of recurrent pain. Roentgenogram showed only

FIG. 8. Case 4. Roentgenogram one year after roentgenotherapy

minimal improvement. Roentgenotherapy was given—125 r, times 10, for total of 1250 r through a lateral port.

Readmitted on Aug. 21, 1951. Apparently three or four weeks prior to admission there was recurrence of rather severe pain. He had been given narcotics for relief from pain. Roentgenograms revealed evidence of improvement but indications of residual activity (fig. 8). Further roentgenotherapy was proposed but refused by patient. Amputation was performed at Veterans Hospital in Coral Gables. Microscopic sections revealed a tendency to new bone formation around the periosteum. This new bone formation was orderly and definitely not suggestive of neoplastic proliferation. Fairly large representative fragments of tumor were still present. Tumor was made up of spindle-formed connective tissue with giant cells. The nuclei of the giant-cells were similar in size and structure. Extensive irradiation effect was apparent by diffuse fibrosis. Scattered throughout were numerous bony trabeculae.

Discussion. 1. Patient was treated with modified protracted and repeated roentgenotherapy. Patient was not satisfied with the slow progressive improvement that one obtains with this type of therapy.

2. Microscopic study indicated irradiation effect but also residual disease. We believe that with time, the therapy would have been effective.

FIG. 9. Case 5. Roentgenogram of anteroposterior view of lesion prior to therapy

Case 5. This 20 year old white man was admitted to the hospital on Oct. 5, 1944. Pain in right knee was noted one year prior to admission. Five months later swelling and increased discomfort were noted.

Examination: Marked swelling of right upper tibia was noted. There was no limitation of motion. Roentgenograms revealed a cystic lesion of upper tibia which appeared to have broken through cortex (fig. 9). There was some discussion of possible malignant change.

Treatment: Curettement was done in November 1944 and the extremity was placed in a cast. Tissue showed benign giant-cell tumor.

Readmitted on April 20, 1945. Patient continued to complain of pain. Roentgenograms revealed some lucencies plus bone production in other areas. Readmitted in September 1945 because of progression of disease (fig. 10). Roentgenotherapy was recommended. 6000 r were given from Sept. 21 to Oct. 16, 1945, divided between four ports; daily treatment varied between 100 to 200 r.

Readmitted in April 1947 with history that he noted gradual increased deformity with inability to flex leg. Roentgenograms revealed a pathological fracture with increased activity of tumor. Malignant change was considered and amputation recommended.

Patient has been well satisfied with artificial limb.

FIG. 10. Case 5. Roentgenogram showing failure following curettement and roentgenotherapy.

Conclusions. 1. Curettement was followed by rapid recurrence of tumor and not controlled by roentgenotherapy.

2. Large irradiation dose (6000 r) is much greater than we recommend. Malignant changes were noted and fits similar cases reported of combined therapy plus large roentgen ray dose.

3. At six year follow-up this malignant lesion shows no recurrence or metastasis.

Case 6. This 25 year old white man was admitted to the hospital on Jan. 14, 1949 with a right intertrochanteric fracture. About 10 days prior to admission the right leg suddenly *gave way* and he fell. Patient had noted pain in right hip and some limitation and pain on motion for several months. Roentgenograms at time of admission showed in addition to the fracture, demineralization and destruction. There was a suggested cystic appearance without expansion of bone (fig. 11).

Treatment: Patient was placed in traction. Biopsy section was obtained and reported to be a benign giant-cell tumor. Traction was continued and roentgenotherapy instituted; factors 220 VA, 15 M.A., 50 cm. distance, 1 mm. cu and 1 A1. 200 r were given daily through an anterior port to a total of 2000 r. Treatment extended from Feb. 2 to March 3, 1939. Surgery, consisting of wedging of the shaft to approximate head and shaft, was done. Re-

FIG. 11. Case 6. Roentgenogram of tumor on admission to hospital

peated roentgenograms showed non-union. Further irradiation in the amount of 3800 r was given from July 26 to Aug. 19, 1949. An artificial prosthesis following resection was unsatisfactory and disarticulation was necessary, Feb. 23, 1950. Microscopic examination failed to reveal any tumor. Specimen showed cancellous bone; no necrosis was noted.

Conclusion. 1. Roentgenotherapy apparently cured the disease and proved and confirmed the diagnosis. The dose employed was probably greater than necessary. It was repeated at the insistence of the Orthopedic Section.

2. Disarticulation was necessary because of non-union.

Case 7. This 31 year old man was admitted to the hospital on Oct. 19, 1948. Patient had previous admission because of pain in right lower quadrant. On each instance he was discharged without a diagnosis. In June 1948 he complained for the first time of upper lumbar pain. On July 1, 1948, while stepping out of bed he suddenly collapsed and a complete paralysis of the lower extremities was noted. There was a flaccid paralysis and anesthesia from

the tenth thoracic vertebra down. Roentgenographic studies showed a collapsed vertebra with soft tissue calcified mass. Review of previous roentgenograms revealed that this process had been present on previous admissions.

Operation revealed a tumor of the vertebra with invasion of the surrounding muscle. The tumor involved the body and lamina. There was extradural involvement present. The slides showed benign giant-cell tumor. Area was treated with roentgen-ray from July 21 to

FIG. 12. Case 7. Roentgenogram taken following operation and roentgenotherapy

Oct. 18, 1948; a total of 3800 r given. The treatment was interrupted by the patient's condition. There was no recovery of the paralysis (fig. 12).

Readmitted on May 14, 1952. Patient apparently did well until two months prior to admission when he developed right chest and shoulder pain. Several subcutaneous nodes appeared over trunk and diplopia of three days duration was admitted. Examination showed marked emaciation with various size nodules scattered over trunk, neck and extremities. Residuals of paraplegia were noted. Roentgenograms of spine showed collapsed vertebra with calcified para-spinal mass, level of the tenth thoracic vertebra. Chest roentgenogram revealed fluid on the right with a nodular density in right upper lobe, thought to represent metastatic nodules. He died on May 14, 1952.

Biopsy of the subcutaneous nodule was considered by some pathologists to represent metastatic malignant giant-cell tumor and others as undifferentiated metastasis, not related. No postmortem was obtained.

Conclusion. 1. Benign giant-cell tumor of vertebra is quite rare. Surgery, plus irradiation, controlled disease for a period of time.

2. It is quite possible that malignant change did occur and produce death.

CONCLUSIONS

The number of cases presented is too small for any statistical analysis. Two of 7 cases becoming malignant is a higher incidence than one anticipates. Case 5 illustrates malignant change (proved by preoperative and postoperative biopsies) that followed operation plus intensive irradiation. It is believed that such a combination of therapy may be significant in the production of malignant change.

Observation over a long period of time of cases treated by irradiation indicates the efficacy of such treatment. It is believed that noncomplicated cases can be cured by low daily and total dose. The treatment is repeated if necessary.

The changes produced by surgical curettement and irradiation are slow in developing over a period of one to two years.

Return to normal bony architecture must not be anticipated. Cystic areas, trabecular alterations and the expanded area persist. The roentgenographic appearance is not materially changed following therapy.

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CYTOLOGY: AN AID IN THE EARLY DIAGNOSIS OF CANCER OF THE CERVIX

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How many of our gynecological patients have unsuspected early cancer of the cervix? It is impossible, visually or by palpation, to diagnose early cancer of the cervix. Our patients must have not only a thorough history and physical examination, but our study must extend beyond the clinical evaluation.

As to research in cancer of the genital tract, and of the cervix in particular, that directed toward the study of cells through cytology warrants hope for early diagnosis and cure Cytology is an office procedure, a *keystone* for the detection of cervical cancer which may not be apparent clinically. In other words, every physician's office can be a *cancer detection center*. The test is simple, painless and relatively inexpensive. It may be repeated as often as necessary without harm or discomfort to the patient. It is neither time-consuming for the physician nor for the patient, and it permits diagnosis in the early stage even before the appearance of subjective or objective symptoms. Thus the test, when doubtful or positive, indicates a demand for biopsy, which otherwise might not be made for years.

Close to 90 per cent of uterine cancers arise in the cervix, and about 97 per cent of cervical cancer arises at the squamocolumnar junction, an area of origin accessible to visual study, to biopsy and to cytologic test.

The surface cell biopsy[1] is highly effective in detecting cancer which is not evident, since large groups of cancer cells may be scraped from very minute lesions. This technic is useful in detecting endometrial and endocervical cancer, as well as the more common epidermoid lesion which develops at the junctional region. If endometrial cancer is present, cells shed from above and collect in the cervical mucous. The first scraping often reveals such cells, while the second scraping usually shows cells from lesions developing at the cervical os.

Until the introduction of the cytologic methods, histologic procedure was the only standard means of cancer detection. However, the procurement of a surgical biopsy was dependent upon symptomatology or upon the presence of a visible target lesion. Cytodiagnosis of the uterus constitutes a remarkable forward step, since it permits detection of cancer in the preclinical or previsual stage.

Brewer[4] of Northwestern University has shown that a patient may have cancer in the cervix for years before it becomes evident. He described a case having had a cervical biopsy in 1931. The microscopic sections showed only cervicitis. In 1949 they were doing routine Papanicolaou smears. The patient was asymptomatic, but the smears were positive for cancer and a biopsy was positive for cancer. They went back to the original block of tissue and sections of 1931. The sections showed only cervicitis. They made new sections of the block from the

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center and found there had been carcinoma in 1931. In other words, for 18 years carcinoma had been present in that cervix without symptoms. He told of another patient who had a positive cervical smear with a cervical biopsy showing normal squamous epithelium. Because of the positive smear, the pathologist turned the tissue over and sectioned the other side, which he would not have done if the smear had been negative. The other side of the biopsy showed carcinoma. This lesion would have been missed by biopsy alone. The smear made them persist in searching for the cancer until they found it. Thus we see that when one uses both cervical smears and cervical biopsies, the percentage of correct diagnosis improves.

We appreciate the fact that neither gross inspection, palpation, clinical evaluation, cytology or pathology is infallible. Rather, each is a complement to the other. Being neither a cytologist nor a pathologist, I would not enter into the discussion of what represents early invasion in carcinoma of the cervix nor argue about the criteria of carcinoma in situ. All of us have seen what we thought were normal cervices or cervices presenting a slight redness of the external or internal os which we perhaps called an erosion.

In our own practice, during that past 20 months, we have taken cervical scrapings from most of our gynecological patients. During that period, we have learned that positive cancer cells may be found under the following conditions:

1. In the cervix showing clinical suspicion of cancer;
2. In the eroded or inflammatory cervix where there is little or no suspicion of cancer, and
3. In the clinically normal appearing cervix.

In the latter two groups, most of us would not subject these cervices to biopsy. It is in these special groups where cytodiagnosis offers its most important contribution, enabling the detection of early cancer in the absence of clinical suspicion and in the absence of abnormal symptoms. It should be emphasized that cancer of the cervix is a young woman's cancer, which considerably magnifies its importance.

We would not take a biopsy section of every cervix. It is neither practical nor justifiable. It is significant, though, that for a simple biopsy to be accurate, a target lesion must be visible. This implies progression to a well-established or advanced stage. Cytodiagnosis is most helpful before this stage is reached, namely, in the preclinical stage.

In preclinical cancer a biopsy may not tell the entire story unless it is a ring biopsy which is followed by serial section studies by the pathologist. Certainly such a procedure is impractical as a screening method. However, it is useful in those cases having positive cytology. As a screening procedure, the simple cervical cell scraping is believed to be highly advantageous.

Tilden[8] of Honolulu took cervical or vaginal smears from 492 women and found carcinoma cytologically in 10 of these, all of whom had surgical biopsy confirmation.

Of 578 women examined by cervical cell scrapings, Fox and I found three un-

suspected carcinomas. These had positive cytology, later confirmed histologically. Two were diagnosed histologically as carcinoma in situ. The third, a clinically normal cervix, had a positive cytology with an histological report of squamous cell carcinoma grade II in *one* area and carcinoma in situ in two adjacent areas. This is a significant point, since complete biopsy studies frequently demonstrate the association of carcinoma in situ in one portion of the biopsy with early infiltration in another segment. Therefore, the ring biopsy technic, as described by Ayre,[3] is useful since it permits the pathologist to receive a ring of tissue at the squamocolumnar junction for serial sections. It permits the clinician to know whether he is dealing with invasive carcinoma or the preinvasive stage before he begins treatment.

As further emphasis, E. L. Hecht[7] points out that a final diagnosis of carcinoma of the cervix should always be corroborated with biopsy before surgical or radiotherapeutic measures are instituted—a point with which we are in complete accord. In other words, the cervical smear method is not intended to replace biopsy as a diagnostic procedure. There is no conflict between the two; the methods are complementary and, when utilized together, will increase the accuracy of diagnosis.

In a series of 181 cases of carcinoma of the cervix reported by Graham[5] and others, the initial biopsy was found correct in 91.2 per cent; the initial smear in 92.3 per cent. The combined methods were wrong in only 1.7 per cent.

Of 112 cervical cancers studied at the New York Post-Graduate Medical School Hospital,[7] 15 were unsuspected. In all 15 of the unsuspected cases, the only reason for taking tissue for biopsy was the positive cytology.

Graham and Meigs,[6] in a study of 432 cervical cancers, found 28 which were unsuspected clinically, and the only reason a biopsy was taken in 19 of these cases was because of the positive cytology.

I believe sufficient evidence has been mentioned to show the advantages of taking cervical smears for cytologic study.

The technic of obtaining the smears. It is suggested that the vaginal speculum be inserted, using little or no surgical lubricant, before palpating the uterus. After exposure of the cervix, a wooden spatula is inserted against the cervical opening. The spatula is rotated with light pressure against the squamocolumnar junction, obtaining a so-called surface cell biopsy.[1] Two cervical scrapings are taken from each patient. The first removes surface cells and mucous; the second removes cells below the exfoliative level. The slides are marked 1 and 2. The secretion is transferred immediately from the spatula to the glass slide with a circular motion. A paper clip is placed on one end of each slide to prevent sticking and, without allowing to dry, they are placed in a fixative solution of equal parts of ether and 95 per cent alcohol for one hour or more. They are then removed; the paper clips are detached, and the wet smear area is covered with two drops of glycerine. A clean slide is placed face to face with the test slide to seal the smear. The slides are then placed in a cardboard or wooden container, with a history form, and sent from the office to the examining cytologist.

CONCLUSION

Cytology is an aid in the early diagnosis of cancer of the cervix. Clinically recognizable cancer of the cervix or definite clinical suspicion usually represents an advanced stage of the neoplasm. Many leading physicians recommend routine cervical cell-scrapings on all patients. The physician's office is the logical cancer detection center. The cervical cell scraping is a rapid, painless, inexpensive procedure and can be repeated as often as necessary. Biopsy confirmation of all positive cytologic cases is imperative, preferably by the ring biopsy technic.

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INDICATIONS FOR SEGMENTAL RESECTION AND LOCAL EXCISION IN PULMONARY SURGERY

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Surgery of the lung for malignant disease, as is true in all cancer surgery, must be radical. This necessarily entails the removal of much normal lung tissue in an effort to completely eradicate the malignancy. Pneumonectomy is indicated in most instances although in recent years lobectomy for pulmonary carcinoma has been given a trial in selected cases.[9] When pulmonary surgery is done for benign conditions, however, the reverse is true. Conservation of as much normal, functioning lung tissue as is possible should be a primary consideration. Refinements in the technic of pulmonary resection have permitted the removal of increasingly smaller units of lung tissue. Rienhoff's[24] technic of individual ligation of the hilar structures, first employed in pneumonectomy, has been carried over into progressively smaller units: the lobe, the segment, and the subsegment.

Segmental resection as such was first described by Churchill and Belsey[8] who employed this method of removing the lingula from the remainder of the left upper lobe. Individual ligation of the bronchi and arterial supply to this segment was done. This technic was also used by them in resecting the basal segments of the lower lobe without removing the superior division. Subsequent modifications and improvements in the technic of segmental resection have been made by Kent and Blades,[16] Clagett and Deterling,[10] Overholt and associates,[20, 21] Chamberlain and Ryan[5] and others. It has been shown that the technic of segmental resection is applicable to all bronchopulmonary segments and subsegments. Single segments may be removed or multiple segments within the same lung or in both lungs may be excised when indicated. Although this procedure was first used in bronchiectasis, indications now have been broadened to include many other conditions.

The increasing boldness of thoracic surgeons has given impetus to further anatomic studies of the lung. Far from being a closed chapter, as one might have supposed 20 years ago, this investigative work has brought to light much information which has contributed greatly to the advance of this branch of surgery. Anatomic studies by Foster Carter,[13, 14] Jackson and Huber,[15] Nelson,[19] Boyden,[2] Brock,[3] Ramsay,[23] and others, have clarified for the thoracic surgeon the segmental anatomy of the lungs. Eighteen distinct bronchopulmonary segments are now recognized, 10 in the right lung and 8 in the left lung.

In the case of certain circumscribed, peripherally situated lesions, or those lying within the fissures, segmental resection is not required. These lesions may often be locally excised by means of wedge resection or enucleation. The suspected nature of the lesion, of course, will often determine the technic of removal

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employed. Local excision is now routinely used in many indeterminate lesions and immediate frozen section will determine whether or not more extensive resection is required. Enucleation or wedge resection may, in some cases, be used in combination with more extensive resection. An example of this would be upper lobectomy for a destroyed tuberculous lobe with enucleation or wedge resection of a small, hard, circumscribed nodule in the middle or lower lobe. Lung abscess may occasionally extend across the fissure and require wedge resection in addition to lobectomy.

Pulmonary biopsy has been used by Klassen[17] and associates in certain diffuse, indeterminate lesions. Through a small, anterior, intercostal incision, a wedge of lung is removed between clamps for the purpose of biopsy. This procedure is relatively innocuous and will often supply the answer to an otherwise puzzling diagnostic problem.

Although the indications for segmental resection or local excision are not always well defined, these procedures are usually considered applicable in certain instances in the following conditions: bronchiectasis, tuberculosis, benign tumors, chronic lung abscess, cysts, blebs and bullae, mycotic infections, metastatic tumors, arteriovenous fistula, and indeterminate lesions.

Bronchiectasis. Bronchiectasis is essentially a segmental disease and tends to involve the bronchopulmonary segments in certain patterns. The basal segments of the lower lobes are most commonly involved. Overholt and Langer[20] found the lingula of the left upper lobe involved with the left basal segments in about 60 per cent of cases and the right middle lobe involved with the right basal segments in 45 per cent of the cases. The superior segment of each lower lobe, however, is rarely affected. It is possible thus to remove only the diseased basal segments and the lingula or middle lobe as required. Chamberlain and Ryan[5] have stressed the importance of the residual superior segment of the lower lobe as a *filler* although its actual contribution to total lung function is probably not great. If the entire lower lobe were removed, the upper lobe would over-distend considerably to fill this space and the diaphragm would become elevated, flat, and fixed with resulting marked decrease in pulmonary function. Pulmonary segmental resections are now being done with increasing frequency because of the ability of the surgeon to select only the diseased areas in each lung for removal. Thus, certain patients may receive the benefit of surgery who were formerly considered not suitable for this type of treatment. The accurate adaptation of segmental resection to bronchiectasis is dependent upon thorough preoperative bronchographic studies. This is especially true in bilateral cases where removal of too much lung tissue would result in pulmonary insufficiency. On the other hand, it is all too easy to leave behind diseased segments as a result of improper roentgenographic demonstration of the bronchiectasis. With proper selection of cases and accurate removal of the diseased segments, surgery has much to offer in this condition.

Tuberculosis. As a result of the successful application of segmental resection in the treatment of bronchiectasis, it was only natural that this procedure should be employed in the surgical treatment of pulmonary tuberculosis. It is well known

that cavitary tuberculosis is limited, in most instances, to three segments of the lung, namely, the apical and posterior segments of the upper lobe and the superior segment of the lower lobe. Because of this anatomic distribution, the possible application of segmental resection can be readily seen. Proper selection of cases is of paramount importance and such factors as the amount of contralateral disease, if any, the chronicity of the disease, drug sensitivity status, stage of the disease (progressive, stationary or regressive), and segmental localization must be considered.

It is certainly true that tuberculosis is a generalized disease, and no claim for complete eradication is made for segmental resection. Excision of the major focus of disease, however, will often remove the *seedbed* of infection and permit the patient to heal with his own resources any remaining small areas of disease. Early results were somewhat discouraging because of the high rate of complications, notably bronchopleural fistula and empyema. These handicaps have gradually been overcome to a large extent, however, through the judicious use of the antibiotics, proper selection of cases, and increased knowledge and experience regarding certain aspects of the operation. Improvement in the postoperative management of these patients with rapid expansion of the lung and obliteration of the pleural space, has resulted in a lessening of the complication rate. Chamberlain and Klopstock,[6] for example, have presented their results in a series of 75 cases of segmental resection for pulmonary tuberculosis with three deaths. The operation as such was responsible for only one of these. In the last 41 consecutive cases no major complications occurred. Chamberlain's[4] series now exceeds 400 cases with comparable results. Ryan, Medlar, and Welles[25] have done simple excision in the treatment of pulmonary tuberculosis by means of wedge or subsegmental resection with no postoperative tuberculous complications. The postoperative course was uneventful and early results were excellent in all cases.

In a personal series of 75 cases there have been no deaths and the complication rate has been extremely low. Four persons in this group required prolonged (up to three weeks) intercostal tube drainage because of failure of re-expansion of the remaining segment or segments as a result of alveolar leakage or small bronchiolar fistula. Permanent bronchopleural fistula did not result in any case.

It is not within the scope of this paper to discuss the relative merits of segmental resection, thoracoplasty or other surgical procedures employed in the treatment of tuberculosis. It may be definitely stated, however, that segmental resection has found wide acceptance in the majority of centers in this country where much surgery for tuberculosis is done. Morbidity and mortality are low, deformity is minimum and results are good. Poor results can, in many instances, be traced to improper selection of cases. Indications for segmental resection include: localized cavities, which have not responded to conservative measures; tuberculomas; and residual nodular disease, which might become active at some future time. In short, this procedure should be considered when the main focus of disease appears to be localized to one or two segments, is apparently irreversible, and is not in the progressive phase. Removal of the superior segment of the lower lobe is often required in combination with upper lobectomy. Two separate

foci can be removed by means of double segmental resection, as, for example, excision of the apical or posterior segment of the right upper lobe and superior segment of the right lower lobe. Bilateral segmental resection is also being done with increasingly satisfactory results in properly selected cases.

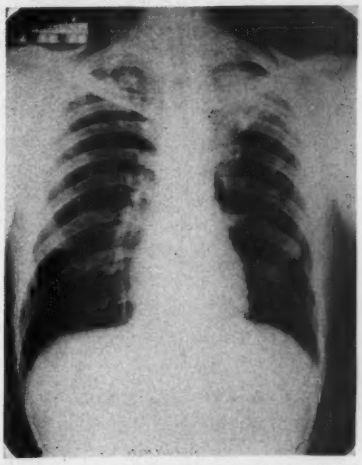

FIG. 1. R. H. Segmental resection for tuberculosis. Initial roentgenogram

FIG. 2. R. H. Segmental resection for tuberculosis. Contraction of area of left upper lobe disease following antibiotic therapy and bed rest.

A peripheral nodule may be removed by simple wedge excision and circumscribed foci have, on occasion, been eliminated by simple enucleation. These procedures are usually done in conjunction with a more major resection but occasionally comprise the entire operative procedure as in the case of tuberculoma

or indeterminate lesion which proves to be tuberculous on pathologic examination. In our experience, no complications have been encountered following these local excisions.

FIG. 3. R. H. Segmental resection for tuberculosis. Roentgenogram following removal of apical—posterior segment of left upper lobe and superior segment of left lower lobe.

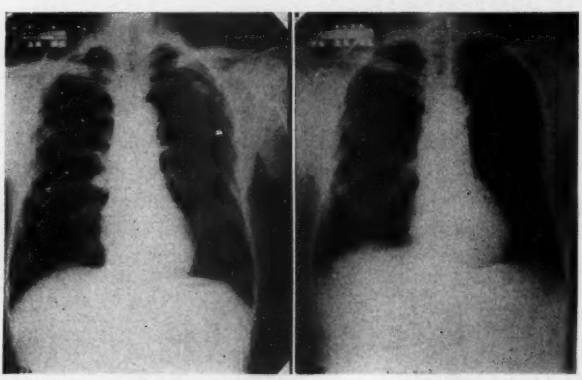

FIG. 4. N. B. Subsegmental resection for tuberculosis. Left: preoperative. Right: following removal of posterior division of apical—posterior segment, left upper lobe.

BENIGN TUMORS. These tumors in the lung are rare and often impossible to diagnose prior to operation. Hamartoma, chondroma, fibroma, neurofibroma, lipoma, and hemangioma have been described and can be removed by segmental resection when so limited. Some of these lesions grow to a large size before symptoms occur, however, and require lobectomy or pneumonectomy.

CHRONIC LUNG ABSCESS. Although often lobar rather than segmental in distribution, it is not unusual at operation to find a chronic abscess limited to one or

two segments. Chamberlain and Ryan[5] presented 13 cases of lung abscess in which segmental resection was possible. They caution against proceeding until the abscess is definitely in the chronic form, and they do not believe segmental

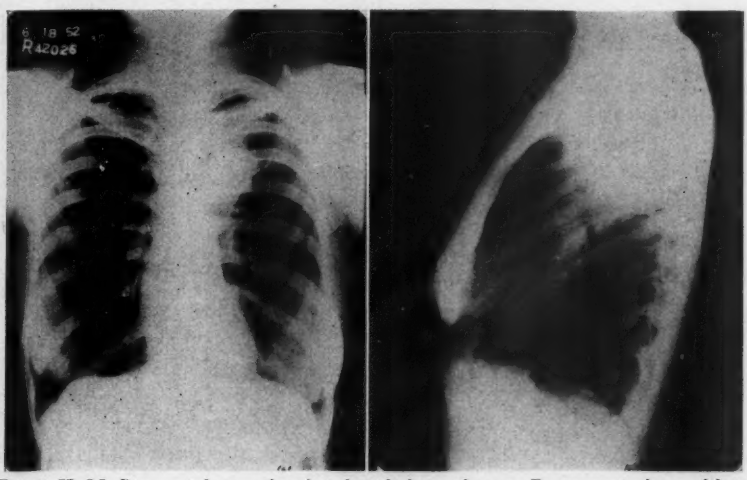

FIG. 5. H. M. Segmental resection for chronic lung abscess. Posteroanterior and lateral roentgenograms showing abscess involving apical—posterior and anterior segments. Left upper lobe.

FIG. 6. H. M. Segmental resection for lung abscess. Following removal of apical—posterior and anterior segments. Left upper lobe.

resection should be done in cases of acute, putrid lung abscess. In several instances previous drainage procedures had been done and 2 cases were done with the drainage tube still in place.

CYSTS, BLEBS, AND BULLAE. Large pulmonary cysts are often more expeditiously handled by means of enucleation than by segmental resection. Lobectomy may be required. Emphysematous blebs and bullae with and without associated spon-

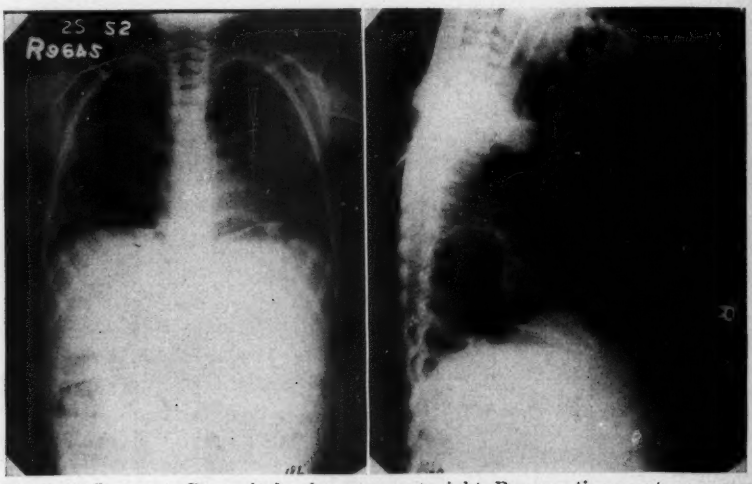

FIG. 7. R. B., age 4. Congenital pulmonary cyst, right. Preoperative roentgenograms

FIG. 8. R. B., age 4. Congenital pulmonary cyst. Following local excision by enucleation technic. No pulmonary tissue removed.

taneous pneumothorax, can usually be treated by simple excision, suture closure of the exposed bronchus, or other local means. Segmental resection is occasionally indicated.

MYCOTIC INFECTIONS. Excisional pulmonary surgery is employed in certain

fungus diseases when sufficiently localized. Melick[18] has assembled by direct inquiry of thoracic surgeons throughout the United States a group of 109 cases in which excisional surgery was done for pulmonary coccidioidomycosis. Of this group segmental resection, local excision, or enucleation of the cavity was employed in 32 instances. Cotton and Birsner[11] have recently reported their results in the surgical treatment of 30 cases of pulmonary coccidioidomycosis. Of this group 8 were treated by segmental lobectomy and 5 by wedge resection with decortication.

METASTATIC TUMORS. In the report by Seiler, Clagett, and McDonald[26] of all recorded cases of pulmonary resection for metastatic lesions, 10 of 62 patients had partial lobectomy or segmental resection. The percentage of cases treated

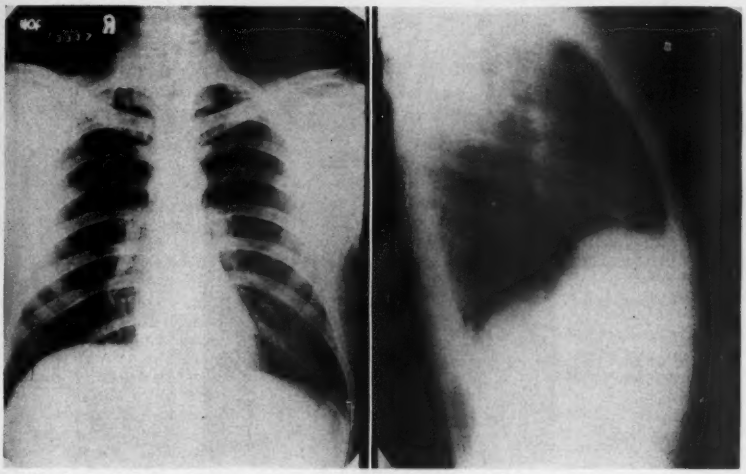

FIG. 9. J. S. Indeterminate lesion, right middle lobe, which proved to be tuberculoma following wedge resection.

by segmental or local excision rather than lobectomy or pneumonectomy at the present time is unquestionably much greater. This is largely due to the increased popularity of segmental resection and to the fact that the most limited operation possible should be done in this condition. Surprisingly good results have occasionally been reported. Tudor Edwards[12] reported 1 patient alive 18 years following removal of a metastatic sarcoma which had metastasized from the fibula. Details of the operation were not given other than to mention that the tumor was removed by "*subtotal lobectomy*." Barney and Churchill[1] reported a patient living and well 12 years after "*partial lobectomy*" for metastatic adenocarcinoma which had metastasized from the kidney.

ARTERIOVENOUS FISTULA OF THE LUNG. The well known tendency of this lesion towards multiplicity dictates extreme conservatism in its surgical treatment. In some instances, the lesion is limited to one segment and can be removed by means of segmental resection. Obliteration of this lesion by means of ligation of

the vascular supply has occasionally been possible. In a personal case it was possible to remove an arteriovenous fistula of the right middle lobe by means of segmental resection of its lateral division. Charbon, Adams, and Carlson[7] removed three arteriovenous fistulas from the right lung of a patient who had a left pneumonectomy seven years previously for the same condition. Two of these lesions were treated by wedge resection and the third was obliterated with multiple interrupted sutures.

INDERMINATE AND MISCELLANEOUS LESIONS. Overholt[22] has repeatedly emphasized the need for exploration in silent lung disease. In peripherally situated lesions it is a common experience that all diagnostic tests will be negative. Delay in treating such lesions is not justified, especially in men over the age of 35 years.

FIG. 10. C. B. Diffuse bilateral asymptomatic pulmonary disease. Diagnosis of Boeck's sarcoid was confirmed following pulmonary biopsy.

When doubt exists as to the nature of an abnormal roentgenographic density, exploratory thoracotomy should be done in most instances and adequate tissue should be obtained for diagnosis. Segmental resection or local biopsy may be done as the location and the size of the lesion dictate. Klassen, Anlyan, and Curtis[17] have advocated pulmonary biopsy in diffuse, indeterminate lesions. This procedure has resulted in no mortality and very little morbidity in their series of 50 cases.

Certain miscellaneous lesions have occasionally been treated by segmental or local excision. These include bronchogenic carcinoma, broncholithiasis, lung trauma, foreign body in the lung, bronchopleural fistula, and nonspecific granuloma.

SUMMARY

Segmental resection and local excision play an increasingly important role in the surgical treatment of pulmonary diseases. They are well established methods

in the treatment of bronchiectasis and tuberculosis and are often indicated in the treatment of benign tumors, chronic lung abscess, cysts, blebs and bullae, mycotic diseases, metastatic tumors, arteriovenous fistulas, and certain indeterminate and miscellaneous conditions.

It is incumbent upon the thoracic surgeon to remove with the disease as little normal, functioning lung tissue as possible. This must not be done, however, at the expense of the disease process. Such a procedure is possible in many of the benign conditions which affect the lung, but should not be considered in primary bronchogenic carcinoma. Many patients who possibly would not tolerate more extensive removal of lung tissue may now be subjected to surgery of this type.

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TRANSPOSITION OF THE ILEOCOLIC SEGMENT AS A SUBSTITUTE STOMACH FOLLOWING TOTAL GASTRECTOMY

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"The lack of adequate gain in weight, the excretion of abnormal amounts of fat in the stools, the slow return of normal muscular strength and the persistence of occasional attacks of abdominal fullness and epigastric burning are still problems to be solved, possibly by new surgical procedures, or by improved postoperative medical management"[4]—thus concluded Longmire in 1947 in a discussion of results following total gastrectomy. Other surgeons[1, 3, 6] have devoted much time and thought toward making this procedure more acceptable to the patient.

We consider that the closest to normal restoration of gastrointestinal continuity following total gastrectomy is accomplished by transposition of the ileocolic segment as a substitute stomach. Credit for this procedure goes to Hunnicutt[2] in California. A report of his first 2 cases was presented at the Western Surgical Association meeting in 1949. Our reaction at that time was unfavorable and we joined others in speculating on the consequences of disagreeable eructations and the magnitude of such an operation upon a patient whom one is not likely to cure. Nevertheless the procedure kept coming to mind, especially on occasions when we were obliged to try to improve the existence of patients with esophagojejunostomies.

In 1951 a patient with a diagnosis of carcinoma of the stomach was prepared for operation in the usual way and in addition the colon was prepared for ileocolic transposition if it seemed indicated. At operation we found an extensive lesion which, to our surprise, proved to be benign on frozen section study. Complete removal of this lesion meant a total gastrectomy (see case 1). Since this was a benign lesion we did not desire to do an esophagojejunostomy and take the risk of having the patient succumb to malnutrition or endure a relatively uncomfortable existence due to regurgitation of bile and inability to eat sufficiently. Neither did we like the thought of leaving part of a lesion which might become malignant. We then entertained the idea of transposition of the terminal ileum and right colon and concluded that if Hunnicutt's observations were accurate, total gastrectomy with utilization of the right colon as a substitute stomach offered the best solution to this problem. This operation was done and the results were so encouraging that, since October 1951, we have followed this procedure in four subsequent total gastrectomies.

We would like to (1) emphasize the desirability of utilizing the ileocolic seg-

* This study was made under the guidance of Dr. Carl S. Williamson who died June 2, 1952 before the results could be prepared for publication.

Presented during the annual meeting of the Southwestern Surgical Congress in Dallas, Texas, October 20–22, 1952.

ment as a substitute stomach, briefly giving our technic, (2) present 3 interesting cases from a pathological standpoint, and (3) discuss several technical problems encountered and errors committed.

The incision we prefer is an oblique upper abdominal incision similar to that described by Rogers[7] in 1951. It begins at the left costal margin one third of the distance across the left rectus muscle from the midline and passes in a straight line downwards and to the right to end at the lateral border of the right rectus

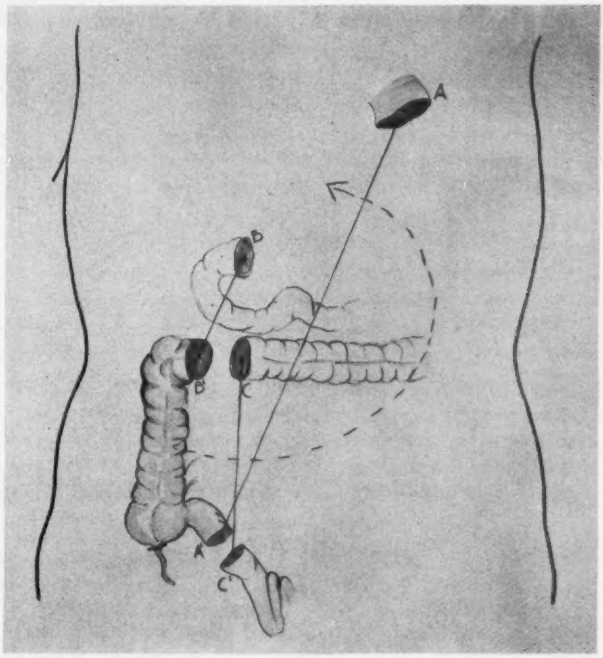

FIG. 1. Schematic representation of sites of division of gastrointestinal tract

muscle at the level of the umbilicus. If the patient is considered a candidate for total gastrectomy following exploration and additional exposure is needed, the incision is extended, upward in a straight line, into the sixth or seventh left interspace to give exposure of the cardio-esophageal junction, duodenum and cecum. This incision is easily closed and heals as readily as other incisions. In closing the wound following our last total gastrectomy we placed a small Steinman pin across the costal arch before approximating the wound edges with chromic catgut. This produced absolute immobilization of the arch which facilitated coughing and lessened discomfort in the postoperative period. The pin was removed two weeks postoperatively.

The total gastrectomy is done according to standard technic. The stomach

may be left attached to the esophagus and turned up on the chest wall, or it ma be detached after an angled clamp is placed across the esophagus. The righ colon is then mobilized by *carefully* freeing up the mesocolon to the midline. The ileum is divided 10 cm. proximal to the ileocecal junction, and the colon is divided at a suitable point between the branches of the right and middle colic vessels. Appendectomy is done, following which the ileocolic segment with its attached blood supply is rotated counter-clockwise until the proximal end of

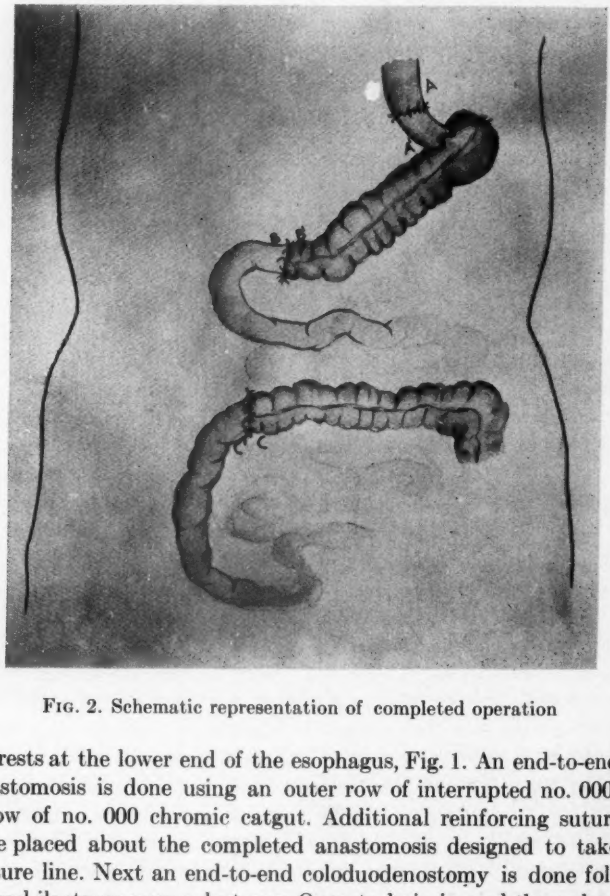

FIG. 2. Schematic representation of completed operation

the ileum rests at the lower end of the esophagus, Fig. 1. An end-to-end esophagoileal anastomosis is done using an outer row of interrupted no. 000 silk and an inner row of no. 000 chromic catgut. Additional reinforcing sutures of no. 000 silk are placed about the completed anastomosis designed to take tension off the suture line. Next an end-to-end coloduodenostomy is done followed by an end-to-end ileotransverse colostomy. Open technic is used throughout, Fig. 2. If sufficient experienced personnel are present, valuable time can be saved after the esophagoileal anastomosis by one team closing the diaphragm and chest portion of the wound while another team proceeds with the other anastomoses. We believe itis as easy to mobilize the right colon, for use as a substitute stomach, as it is to prepare any other segment of bowel for such use, and it can be ac-

complished even more quickly than constructing a pouch from two segments of small bowel.

At operation a Levine tube is pulled down through the anastomosis into the new stomach and left in place with suction applied until peristalsis returns. As Hunnicutt has pointed out, the right colon absorbs fluids and one need not worry about distention from fluid accumulation, however, we believe the tube adds a safety factor to the patient who is an aerophagic. There have been no complications from leaving the tube in place for two to three days postoperatively. During this time clear liquids are given orally, and the diet is gradually increased after removal of the tube.

Leakage at the esophagoileal anastomosis and gangrene of the ileocolic segment have been reported[5] as complications following the transporition procedure. These complications and an error made on our fourth case serve to emphasize the necessity of careful preservation of the arterial supply and venous drainage of the transposed segment.

CASE REPORTS

Case 1. A 62 year old man was first seen in the medical clinic in September 1951 complaining of heaviness and fullness in the epigastrium of three months duration. His appetite had remained good and he had lost only two pounds in weight. A diagnosis of "neoplasm of the greater curvature of the stomach" was made by roentgenogram. He was operated upon on Oct. 21, 1951 and an extensive papillary adenoma was found. This lesion extended from the lower 1 cm. of the esophagus to within 2 cm. of the pylorus. A total gastrectomy with transposition of the ileocolic segment was done following the frozen section study of the tumor. His convalescence was uneventful and he had returned to his occupation as a manual laborer when last seen on Oct. 1, 1952. His appetite is good; he eats three normal meals daily and has gained 20 pounds in weight since his operation.

Case 2. A 60 year old man had had careful observation and treatment for intermittent low retrosternal pain by several competent physicians since 1947. During this time several gastrointestinal roentgenographs were reported as normal. In January 1952 he was admitted to the hospital with nausea and vomiting for the first time. His extreme nausea was not relieved after one week of gastric suction and an exploratory laparotomy was done on Jan. 14, 1952. A linitis plastica type of lesion was found involving the distal $\frac{4}{5}$ of the stomach. No palliative procedure was feasible and we elected to do a transposition operation. His convalescence was uneventful. Approximately three months postoperatively he returned to work as a special officer. His appetite was excellent, but he was troubled intermittently by abdominal cramps due to incomplete small bowel obstruction. In June 1952 the intestinal obstruction was of sufficient degree to warrant operation at which time there was accidental soiling of the peritoneum and fatal peritonitis ensued. Autopsy revealed microscopic evidence of carcinoma in the lower end of the esophagus, proximal duodenum, peripancreatic nodes and in some of the intestinal adhesions.

Case 3. A 56 year old man gave a history of being unable to eat for five weeks with marked weight loss. At operation an extensive gastric neoplasm was found which was producing obstruction at the cardia, but no evidence of extension was present except adherence to the tail of the pancreas and regional lymph node enlargement. A total gastrectomy was done utilizing the ileocolic segment as a stomach pouch. The entire procedure required four and one-half hours. D-tubocurarine was administered to obtain sufficient relaxation for wound closure and this caused cessation of voluntary respiration which persisted even

after administration of tensilon. After closure of the abdomen his condition seemed fairly satisfactory. His blood pressure was 100/80 and it remained so until two hours later. At that time, while being transferred to a respirator, cardiac arrest occurred which did not respond to open chest massage and stimulants. Autopsy was refused.

Case 4. A 61 year old man was seen in the surgical clinic in February 1952 because of protruding, painful hemorrhoids. During the system review a history of a five pound weight loss and slight *indigestion* was obtained, so a gastrointestinal study was done. The roentgenologist reported a small prepyloric lesion of the stomach. At operation on Feb. 10, 1952 a small, infiltrating, prepyloric lesion was identified and, in addition, a polypoid lesion with fixed base high on the greater curvature of the stomach was present. A total gastrectomy was done. The mesenteries were quite fat and friable and in mobilizing the right colon a tributary of the ileocolic vein was partially torn away. Due to the thickness of the mesentery we were not aware that hemostasis compromised the venous return of the ileocolic segment. At the completion of the first two anastomoses it was evident that the ileocolic segment was infarcted, so it was resected and a 25 cm. segment of the transverse colon was utilized in an antiperistaltic manner.

Examination of the specimen after surgery revealed a third separate lesion low on the greater curvature. This lesion was soft and polypoid. All three lesions were malignant, and all presented a different histologic picture.

His convalescence was uneventful except for instability of the left costal margin making coughing difficult and atelectasis more troublesome, culminating in partial wound separation on the eighth postoperative day. Secondary closure was followed by satisfactory convalescence. Serial roentgenographic studies showed the colon segment emptied without delay. In the supine position barium flowed back up to the cricopharyngeus. When last seen on Oct. 20, 1952 he stated that he eats a normal diet and the only complaint is that while he is eating he has the sensation that something is moving upwards in his chest. This is not present after meals and there is no regurgitation of bile. This patient has applied for his pension stating that he had been looking for an excuse to stop work. He has gained 25 pounds in weight since operation.

Case 5. A 53 year old man who was first seen in the Outpatient Department in May 1952 complaining of vague epigastric distress. Roentgenographic examination at that time revealed a possible lesion of the cardia. Immediate repeat examination was reported normal. In August 1952 he returned, at which time he complained of vague epigastric discomfort, loss of appetite and 20 pounds weight loss. Repeat roentgenographic studies revealed a polypoid lesion low on the greater curvature of the stomach. The chest was normal. At that time a celiotomy was done and the lesion described by the roentgenologist was identified. In addition, a large cauliflower lesion 10 cm. in diameter on the anterior wall of the stomach was present and almost obstructing the cardia. The nodes around the stomach were all enlarged and firm, but there was no evidence of further spread.

A total gastrectomy with transposition of the ileocolic segment was done. Convalescence was uneventful. During the six weeks following operation his appetite has been excellent and he has gained from one to two pounds each week.

COMMENT

With present day surgical facilities we believe that utilization of the ileocolic segment as a substitute stomach can be done safely. We believe it is reasonable to offer patients with extensive incurable gastric lesions, on whom palliative partial resections cannot be done, a few months of comfort by this procedure. If total gastrectomy with transposition of an ileocolic segment is to be done on patients with extensive lesions, it probably should be reserved for those with

linitis plastica, lymphosarcoma, leiomyoma with sarcomatos degeneration and selected carcinomas of the cardia. Lee[3] has suggested using a section of transverse colon in selected cases, and while our single case is doing quite well, we believe the ileocolic segment functions better as a substitute stomach.

SUMMARY

We believe that transposition of the ileocolic segment as a method of restoring continuity of the gastrointestinal tract following total gastrectomy has the following advantages:

1. The reservoir function of the stomach is retained. Many physicians working with the problem of total gastrectomy believe that physical absence of a gastric reservoir constitutes the basic problem in nutritional deficiency.

2. The function of mixing is retained. Also, as Hunnicutt[2] points out, the mucous secretion of the colon segment is admixed with the meal which prevents or decreases adverse effects upon the jejunum.

3. The patient has a good appetite; has no dietary restriction and can comfortably eat three meals daily.

4. There is freedom from postprandial distress and the annoying regurgitation of intestinal contents.

5. These patients gain weight and strength rather promptly and maintain adequate nutrition.

6. The secretagogic effect of food as it passes through the duodenum is retained.

7. There is more normal mixing of food with pancreatic and biliary secretions.

8. There is normal progress of the meal through the small intestine in contrast to the previously noted rapid transit of the meal following esophagojejunostomy. So far stool fat excretion studies, the five hour glucose tolerance test and the complete blood count on our first case are essentially normal, without benefit of any specific medication. Therefore, we anticipate that this operation will result in reasonably normal excretion of stool fat and nitrogen.

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MEDICAL SHOCK WITH SUDDEN SHIFTS OF EXTRACELLULAR AND INTRACELLULAR FLUIDS

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An often forgotten principle of parenteral fluid therapy is that glucose solution provides water for obligate *expenditure* by the body, whereas electrolyte solutions are given with the specific intent that they shall be retained.[17] Glucose, by itself, contributes to the *conservation* of body water and electrolytes during fasting,[16] but cannot compensate for obligate water losses when given with electrolyte solutions designed to be retained. Thus it is that glucose solutions are designated as *maintenance* fluids to supply the physiologic requirements, whereas electrolyte solutions, with or without glucose, are designated as *repair* solutions to provide replacement of recognized deficits.

Unfortunately, the identity of the appropriate repair solution has not and cannot be defined as exactly as has been done for maintenance solutions of glucose water. Although saline solution was used for many years as a repair solution, recent concepts about the sodium:potassium ratio and the relationship of intracellular to extracellular fluid have fostered the *balanced electrolyte* solution containing many cations.[6, 7, 11, 14] Clinical experience suggests that in certain dehydrations it would be desirable to use more potassium and less sodium than is provided in currently approved replacement. It is the purpose of this discussion to focus attention on this phase of the problem with emphasis on the sudden shifts of the extra- and intracellular fluids and electrolytes across the body membranes, both in an attempt to maintain osmotic equilibrium and as a result of the *metabolic* response to trauma.

Conceivably osmotic equilibrium between the intracellular fluid and extracellular fluid might be brought about by transfer of water across cellular membranes, by transfer of ions across cellular membranes, or by both processes. Studies in 1935 by Yannet and Darrow[3] indicated that transfer of water was the chief means of adjusting osmotic equilibrium between the intracellular fluid and extracellular fluid and their intervening relatively impermeable cellular membrane.

Further studies by Mellors, Muntwyler and Mautz[21] supported the view that the concentration of sodium in the extracellular fluid played an important part in the exchange of water between the extracellular fluid and intracellular fluid, and that a transfer of water constituted the principal adjustment in the maintenance of a uniform osmotic pressure.

With these observations in mind the studies of Elkinton, Winkler and Danowski,[9] Darrow and Yannet,[3] and most recently Abbott and his group[1] identifying the danger of parenteral fluid by hypodermoclysis become apparent. They have

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shown a paradoxical decrease in plasma volume when isotonic or hypertonic solutions low in, or devoid of, electrolytes are given by clysis or intraperitoneally. As salts transfer from the plasma and interstitial fluid to the side of clysis, the osmolarity of the extracellular fluid is reduced and a shift of water to the intracellular compartment occurs. Thus there is an increase in the intracellular fluid volume, a relative decrease in plasma volume without appreciable change in the total extracellular fluid volume. Hypotension, oligemia and the subjective signs of peripheral failure and cerebral edema occur frequently, usually within four or five hours after administration of the hypodermoclysis. In the usual administration of hypodermoclysis, the rate of administration is so slow that the untoward effects of altered osmolarity are compensated by a number of mechanisms. The inherent danger becomes fully apparent, however, when added hyaluronidase solution makes possible the rapid administration and diffusion of glucose by clysis.[1] Here the pattern of hypotension and oligemia becomes obvious.

Experiments and observations of this general type serve to emphasize the importance of osmolar equilibrium, *per se*, between the extracellular and the intracellular compartments. In the above instances, the precipitating factor is an alteration in the water content of the extracellular fluid with concentration or dilution of the normally balanced electrolyte mixture. Under these circumstances, it is not surprising that shifts of water between the two compartments seem to be the dominant feature of restoration of osmolar equilibrium. The mechanism is complicated, however, by coordinated shifts in electrolytes with sodium and potassium transfers being especially important. As shown by Yannet and Darrow,[24] shifts of water into the cells in response to hyposmolarity equalled only two-thirds of that predicted by calculation if water was the sole adjusting agent. It is now established that cellular as well as extracellular electrolytes are involved in many, if not most, disturbances in body water and electrolytes.[4, 5, 13, 15] As will be discussed later herein under hypochloremic alkalosis, an excess of relatively unbound cation may shift primarily with water shifts occurring secondarily. Thus, osmolar alterations between the two major fluid compartments may be conditioned by either of two changes: (1) alterations of concentration of a balanced electrolyte solution, or (2) excesses or deficiencies of ions.

The matter of ionic participation in osmolar exchange is complicated by the fact that renal regulation of sodium and potassium excretion comes under adrenocortical influence. The sympathico-adrenal discharge characteristically causes renal sodium retention, potassium excretion, and, in addition, an intracellular *sodium shift*.[22]

Within the framework of this discussion, it is now possible to seek a more precise definition of *medical shock*. We believe it preferable to restrict usage of this term to those situations wherein an oligemia is absolute as a consequence of fluid and electrolyte imbalance. The genesis of the oligemia is a reduced plasma volume with hemoconcentration due to reduction of the total extracellular fluid of which the plasma volume is an integral constituent.

There are two types of dehydration with extracellular fluid deficits and associated oligemia:

1. The pattern of extracellular fluid deficit associated with relative intracellular fluid excess—the prototype of this pattern is the hypochloremic alkalosis of pyloric obstruction.

2. The pattern of extracellular dehydration with intracellular fluid deficits as well. In our experience, the prototype of this pattern is hypochloremic acidosis due to diabetes, late intestinal obstruction or diarrhea.

Hypocholremic Alkalosis. In the patient depleted by vomiting from pyloric obstruction, the electrolyte disturbance has been categorized as *hypochloremic alkalosis*. Characteristically there is a relative excess loss of chloride with a resultant metabolic alkalosis associated with an intracellular sodium shift and potassium loss. Corrective therapy is now well established and consists of saline solutions with added potassium.[8, 19] Indeed, injudicious treatment with saline solution alone leads to an increased cellular sodium shift and edema without correction of the hypochloremia.[10]

Hypochloremic Acidosis. In the dehydration due to late intestinal obstruction or diarrhea there develops an acidosis with a loss of water, a relative excess loss of sodium and a major loss of potassium. In the normal metabolic response there is a minor intracellular sodium shift possibly due to the sodium deficit. Indeed, at times, there is a loss of normal intracellular sodium in the body's attempt to compensate for the extracellular sodium loss and acidosis.[7] These shifts result in the extracellular and intracellular dehydrations characteristic of acidosis. As part of the pattern of dehydration, oliguria occurs and potassium excretion is limited to a degree. Frequently the plasma potassium is elevated,[23] however, at other times, there develops an extracellular depletion of potassium only partially replaced by potassium from the cells.[21]

Although potassium has been universally accepted in the treatment of hypochloremic alkalosis, there has been considerable reluctance to use potassium salts in the resuscitation of the patients with dehydration and metabolic acidosis. The blood urea nitrogens are relatively constantly elevated in the latter, and, as mentioned, serum potassium levels are frequently elevated. The hazards of potassium intoxication have been so well publicized that all have been reluctant to give potassium in the face of this evidence of impaired renal function. In retrospect, however, it is obvious that many times the kidney has been impugned in the face of excellent evidence of satisfactory function in the form of a high specific gravity and a low pH of the urine.

Recently studies of metabolic acidosis treated with saline and sodium bicarbonate solutions alone[6] have revealed shifts of sodium into the cells with resultant intracellular edema. In prolonged sodium chloride–sodium bicarbonate replacement therapy without the potassium ion, profound alkalosis may be produced not as a result of renal failure but as normal renal function in the absence of potassium.[7] Indeed, all too frequently resuscitation of late obstruction is associated with the sudden development of recurrent hypotension, oliguria, restlessness and fever which we believe is due to the resulting cerebral edema associated with massive sodium shifts into the cells.

Darrow[4], in 1945, suggested adding potassium chloride to the accepted sodium

chloride–sodium bicarbonate therapy of acidosis in order to minimize the transfer of sodium into the cells. With the addition of potassium chloride the mortality rate in severe infantile diarrhea was reduced from 30 per cent to 5 per cent.[18]

With these facts in mind we became interested in studying our replacement therapy in acidosis associated with late intestinal obstruction. We have emphasized the use of both sodium and potassium in our repair solutions as first recommended by Falconer[12] in 1939 and recently by many authors.[2, 7, 10, 11] The dangers of intravenous administration of potassium in oliguric or anuric patients can be avoided if glucose-saline solutions are given initially to determine the renal response to hydration. By following this initial fluid administration with a saline-bicarbonate-potassium solution (Ringer's lactate with added potassium), we have seen marked and early improvement in our patients clinically, *i.e.*, disappearance of the aesthenia, weakness and hypotension so frequently seen in later obstruction. By administering the potassium early and thus preventing the sodium cellular transfer seen with saline treated obstructions, we have markedly lessened our incidence of cerebral edema and its associated hypotension and death. Again, as with hypochloremic alkalosis, the key to successful therapy is the addition of the potassium ion to the previously used sodium chloride–sodium bicarbonate solutions.

SUMMARY

Medical shock as a result of extracellular and intracellular water and electrolyte shifts is classified into two general categories: (1) hypochloremic alkalosis, and (2) hypochloremic acidosis.

Their diagnosis, physiology and treatment are discussed.

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CARCINOMA OF THE STOMACH—A CHALLENGE TO THE PHYSICIAN*

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Although surgery is generally recognized as being the only form of treatment likely to produce any benefit for patients with carcinoma of the stomach, the cure rate following such surgery is so low that the opinion is often *voiced*, even by experienced surgeons, that cancer of the stomach is a hopeless disease. This opinion seems justified when one takes cognizance of the 40,000 deaths annually in the United States, and an over-all five year survival rate of less than 5 per cent for patients with the disease. Yet certain authorities, such as Welch,[13] state, on the basis of statistics, that in the early stages of certain types of gastric cancer, cure rates up to 40 or 50 per cent can be prognosticated.

A recent study of 144 cases of patients with gastric cancer seen in the Roper Hospital in an 11 year period[9] has been brought up to date, and indicates that only 11 of these patients are alive without evidence of recurrence, and only 6 have survived more than five years after operation. Calculated on the basis of the number (92) of patients diagnosed at least five years before the time of the study, this represents a five year survival rate of 6.4 per cent. The most striking fact brought to light by this study was that only 17 of the 144 patients (*i.e.* 11.8 per cent) arrived upon the operating table in a stage of the disease which still appeared to be curable, the obvious tumor being confined to the stomach and regional nodes. This is not a peculiar local finding, but one which is duplicated in most general hospitals throughout the country. Of these 17 patients, 10 are alive without evidence of recurrence, in addition to 1 patient for whom *palliative* resection was done six years ago, all more than two years after operation. While this series is quite small, it is comparable to the experience of many surgeons, and the data presented should serve as a cogent argument to improve all methods of arriving at an early diagnosis of this insidious disease.

The surgeon is, naturally, interested in the technic of mechanical therapy which will cure a given condition. In almost every surgical journal, at least once a year, articles concerned with refinements in the technic of gastric operations appear. Surgeons have adopted a more aggressive attitude toward cancer of the stomach, and the general principle has been established that *exploration is indicated unless there is unquestionable evidence of distant metastases.* As a result of more thoughtful preparation for operation, better anesthesia, increased availability of blood, improved understanding of fluid and electrolyte balance, more attentive postoperative care, and the use of antibiotics and gastric suction, the mortality rates of both partial gastrectomy and total gastrectomy have declined

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precipitously in recent years.[1, 5] Many surgeons believe that partial gastrectomy is an adequate operation for cancer of the stomach, provided the gastro-hepatic and gastro-colic omenta, as well as the greater omentum, which serve as the primary channels of lymphatic metastasis, are removed in continuity with the stomach. All of the five year survivors in the series quoted above were treated by partial gastrectomy. Such an operation does not take into account early metastatic involvement of the peri-pancreatic nodes, and appreciation of this fact has prompted Walton[12] to propose partial pancreatectomy and splenectomy as additions to the procedure. McNeer and his associates,[7] as a result of autopsy studies of patients dying with recurrent cancer after partial gastric resection, indicated that there was local recurrence in the gastric stump in 80.5 per cent of their cases, and, on this basis, advocated total gastrectomy as the treatment for all early gastric cancers. This position has been supported enthusiastically by Lahey and Marshall,[5] but one group from the Mayo Clinic[10] points out that a philosophy of radicalism is not sufficient to prove that total gastrectomy is indicated in every case. The latter group prefers to individualize the cases, removing the areas which might be involved on the basis of the known pathologic characteristics of a given lesion. They found no correlation between duration of life and the distance between the tumor and the line of incision in the stomach.

It must be admitted that total gastrectomy is a crippling procedure, often resulting in persistent nutritional difficulties. Some of these difficulties may be obviated by the use of substitute gastric reservoirs, like the ileocolic transplantation described by Hunnicutt,[4] but such procedures are still *untested*, and unquestionably increase the risk of an operation which is itself of considerable magnitude. To date, no large series of cases has been presented to offer convincing evidence that the cure rate will be improved by the routine employment of total gastrectomy. With these considerations in mind, it is the practice in our institution to do radical subtotal gastric resection for antral lesions of the exophytic type, reserving total gastrectomy for the scirrhous or linitis plastica carcinomas, and those involving the upper portions of the stomach.

As far as palliation is concerned, it has been pointed out[9] that gastroenterostomy, although it will short-circuit an obstructed pylorus, will not increase significantly the life span of the afflicted person. Greater palliation is achieved by gastrectomy, notwithstanding hepatic or para-aortic metastases, provided that ascites or abdominal carcinomatosis is not present. When contiguous invasion of adjacent structures is found, a remarkable degree of palliation can sometimes be achieved, as noted by McNeer and James,[6] by resection of portions of adjacent organs, such as the pancreas, liver, and transverse colon, in continuity with the resected stomach. One patient in the Roper Hospital series serves as an illustration of this point. At the time of operation, a portion of the liver involved by contiguous metastasis was removed in continuity with the stomach. Six years later this man is alive without evidence of tumor recurrence.

Without adopting an unduly pessimistic attitude, it appears that the development of outstanding improvements in the technics of gastric surgery in the near future is improbable. If present technics must be relied upon, results in this

disease will not be improved to a significant degree until patients arrive upon the operating table much more frequently in a curable state. Thus a challenge to the physician presents itself, to improve methods of case finding and diagnosis.

Perhaps the most important element in the diagnosis of gastric cancer is alertness on the part of the physician to the possibility of the presence of such a disease. Mild dyspeptic symptoms, which are persistent, should immediately arouse suspicion, especially if the patient is in the fifth decade of life or older. If cancer of the stomach is to be cured, the epigastric mass and the Virchow's node must no longer be thought of by the practitioner as pathognomonic signs of the disease, since these are usually signs of a hopeless situation. Roentgenography offers the best method of recognition of early gastric carcinoma; in the hands of a competent roentgenologist at least 95 per cent of gastric lesions should be recognized. Gastric analysis after histamine is helpful, because gastric cancer is often associated with achlorhydria, but the presence of acid does not by any means rule out the possibility of cancer. Gastroscopy is a valuable aid in diagnosis, but has its limitations. An experienced gastroscopist may be able to recognize malignancy by its appearance in some cases, but in others, the lesion may appear benign, but prove to be malignant on microscopic examination. The determination of the presence of occult blood in the stools is also included in the diagnostic methods. Since it is known that meat in the diet will often cause the benzidine test to be weakly positive, the practice of maintaining a patient on a meat-free diet for two or three weeks, while examining his stools, has developed. From the diagnostic viewpoint, this seems a waste of valuable time, and from the surgical viewpoint, it is poor preparation for surgery. Study of material aspirated from the stomach and stained by the Papanicolaou technic has been disappointing in our hands. In the past year, an experimental project has been launched in the Medical College of South Carolina, the goal of which is to compare results of Papanicolaou smears obtained by each of two methods from every case of cancer of the stomach. The first of these methods is the use of the abrasive balloon described by Cooper,[2] and the second is the use of papain, a mucolytic substance, to dissolve the mucous barrier of the gastric mucosa, as proposed by Traut.[11] The results of this study to date are insufficient to warrant any conclusions, but it is already apparent that both methods have their limitations. Positive smears are rarely obtained in cases of linitis plastica carcinoma, where the involvement is predominantly submucosal, or in cases with a marked degree of pyloric obstruction. The final diagnostic weapon is, or should be, exploratory laparotomy. In the words of W. J. Mayo, written more than 50 years ago, "The exploratory incision for suspected cancer of the stomach, instead of being a last resort, should be one of the first, and promptly undertaken if the condition cannot be proved to be nonmalignant." These words should be heeded with more alacrity today than when written, since the mortality rate of exploratory laparotomy alone now approaches zero.

An analysis of 34 years of experience with carcinoma of the stomach at the Presbyterian Hospital by Harvey and his co-workers[3] was extremely discourag-

ing, since it indicated that the duration in time between the onset of symptoms and medical consultation was as long in the later years of the study as it was in the earlier years. This patient delay may be due to ignorance on the part of the lay public of the fact that dyspepsia may be a danger signal of cancer. Such ignorance is being diminished by the educational efforts of the American Cancer Society. More often, such delay is due to ill advised self-medication with proprietary remedies which are artfully and attractively presented through all of the modern advertising channels, and which, unfortunately, often do ameliorate temporarily the symptoms of early gastric cancer, so that the progress of the disease is masked. Perhaps at some future time, the establishment by enlightened legislators of a more rigid control over such irresponsible advertising may diminish delay in diagnosis.

In a study of any series of cases of gastric carcinoma, physician culpability is also apparent, and Boyce[1] has presented an interesting summary of some of the reasons for physician delay. These merit listing and review.

1. The opinion of the physician that cancer of the stomach is a hopeless disease. This can be altered only by improved follow-up statistics and professional educational efforts.

2. An unjustifiably optimistic rationalization over the roentgenogram. This applies particularly to the gastric ulcer problem, discussed below, and to those cases in which the pertinent roentgenologic finding is a stiffening of the gastric wall with a loss of peristaltic movement.

3. Symptomatic treatment. This is the simplest recourse of a busy physician, when confronted with a patient with chronic indigestion, and, unfortunately, often produces a remission of symptoms of sufficiently long duration to give a false sense of security. In many instances, this is the product of economic considerations, particularly the inability of the patient to pay the cost of the roentgenologic examination.

4. The ulcer-cancer problem. This problem has been brought into focus again by a recent excellent editorial by Marshal.[8] Most internists and surgeons recognize that ulcerative lesions on the greater curvature and in the pre-pyloric area are so likely to be malignant that operation is indicated without further delay. The lesser curvature ulcers, which are the most common, are usually treated by a rigid anti-ulcer regimen in the hospital for two to three weeks, and if healing has not occurred during that time, operation is advised. While this idea is usually accepted in principle, the stated time interval is often remarkably elastic, and efforts to heal the ulcer are often prolonged for weeks or months, only to discover an incurable cancer when operation is finally advised. To these considerations might be added the thought that benign gastric ulcers which do not heal promptly on such a regimen are prone to recur after they do heal, and that the results of partial gastrectomy for benign gastric ulcer are excellent.

5. Treatment for other disease. Frequently, patients with vague abdominal symptoms, later found to be due to cancer of the stomach, have been treated for hernia, gallbladder disease, pancreatitis, colitis, and other entities, without serious attempts at thorough diagnosis.

6. Missed opportunities. Patients under observation for disease of some other system occasionally present symptoms which should be suggestive of cancer of the stomach, but which are ignored, because they are not related to the present illness.

7. Emphasis on psychosomatic medicine. This, as Boyce states, often proves disastrous. It is axiomatic that the possibility of the presence of serious organic disease should be thoroughly explored before treatment of functional disorders is undertaken.

8. Repetition of diagnostic tests already pointing to malignancy. Such repetition is particularly likely to occur on large teaching services. As Allen O. Whipple once stated, in connection with pancreatic carcinoma, "Some of these patients are literally studied to death."

SUMMARY

Gastric cancer is a curable disease in the early stages, but it is one of such an insidious nature that its presence is seldom detected before a state of incurability is reached unless the physician has a very high index of suspicion. It is unlikely that marked improvements in salvage rates will result from further refinements of surgical technics, but there is much room for progress in methods of arriving at a diagnosis of the disease at a stage curable by present technics.

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EDITORIAL

THE JUSTIFICATION FOR PALLIATIVE GASTRECTOMY IN ADVANCED CARCINOMA OF THE STOMACH

Little more than 10 years ago a monograph on carcinoma of the stomach by one of the most distinguished surgeons of the country carried the statement that 90 per cent of the palliative procedures for carcinoma of the stomach took the form of gastro-enterostomy, resection as a palliative operation being limited to a relatively small group of cases. Today that situation is completely reversed. Short-circuiting operations are made only occasionally. Many surgeons, in fact, think that there is no indication for them at all, on the ground, as the late W. J. Mayo expressed it, that *gastro-enterostomy is a hopeless operation which merely enables the patient to live longer and suffer more.* The place once held by gastro-enterostomy is now occupied by palliative gastrectomy. The increase in the number of these operations, and not, unfortunately, any increase in resectability, explains the large number of gastric resections now being done for carcinoma of the stomach.

Operability has ceased to be a matter of absolutes in this disease. Curative resection is now being undertaken in cases that would once have been regarded as inoperable. This change in concept is wise and proper. It conforms with the first law of the surgery of malignant disease: that surgery should be directed toward removal of the primary growth. The treatment of gastric carcinoma, as Pack and McNeer have emphasized, is based on philosophy more than on technic. If a surgeon's philosophy does not urge the attempted removal of every gastric carcinoma which he encounters, then he should not be treating the disease at all. The human equation enters into every such decision, but there is no doubt that as the surgeon gains in experience, his contraindications to resection, whether palliative or curative, become fewer and fewer.

Whether or not palliative gastrectomy can be done depends upon a number of considerations. The size of the tumor does not settle the question. A large fungating growth is no more difficult to remove than a small infiltrating tumor. The location of the growth plays a larger part in the decision. Lesions on the lesser curvature are more amenable to resection than those on the greater curvature. Lesions in the midportion of the stomach are more amenable to resection than those at the pylorus and are far more readily removed than those at the cardia, which tend to invade the esophagus. Involvement of the esophagus is usually a contraindication to palliative resection, since the total operation, which is likely to be required under the circumstances, carries too high a mortality rate to be lightly undertaken.

The presence of direct extension to neighboring structures, including the gastrohepatic and gastrocolic omentum, the pancreas, and the transverse colon or mesocolon, does not contraindicate resection but does demand thoughtful consideration before it is undertaken. One must be very certain that the benefits

likely to be secured outweigh the increased risk involved in resection of other structures in addition to the stomach. Metastases to the liver and to more distant structures were formerly regarded as a definite contraindication to resection. This is no longer true. If local removal of the primary tumor is feasible, the operation is justified in the expectation that the rate of spread will be retarded.

Apparent spread of the growth to the lymph nodes is also not a contraindication to palliative gastrectomy. For one thing, all of the regional nodes can usually be removed. For another, it is impossible to tell by gross inspection whether the enlargement is the result of malignant change or is merely inflammatory. It is not worth while delaying the operation for frozen section. The node selected for examination may be uninvolved while other nodes are the site of malignant change. Vice versa, the finding of malignant tissue in one node tells nothing about the status of the other nodes. Gross disease in unresectable lymph nodes is, of course, another matter.

Age should never be a factor in the decision for or against resection. With the proper safeguards, a patient of advanced years tolerates the operation well. Moreover, as a number of observers have pointed out, if a patient in the older age group survives palliative resection for a few years, his life expectancy may be quite as long as it would have been if he had not developed the disease. In other words, curative and palliative operations lose some of their distinctions in the older age groups.

From the technical standpoint, then, the decision for or against palliative resection is chiefly based upon whether or not local resection of the malignant tumor is possible. Gastrectomy is still a serious operation, but it has lost most of its risk. Surgical technics have become more efficient. Anesthetic technics have improved. Adjunct measures, particularly the liberal use of whole blood, have made the patient safe for surgery. As a result, the mortality rate of palliative resection is little higher than the mortality rate of curative resection, and in most reported series it is considerably lower than the mortality rate of gastroenterostomy.

There is today no justification for the *argument* that *a patient with advanced carcinoma of the stomach has nothing at all ahead of him.* He may ultimately be doomed. This is a lawless disease. But even when we are all too certain of the final outcome, there may still be hope for an extension of life. In the occasional case, what is done as a palliative resection proves to be a curative procedure. One of the strongest arguments for the operation is that local recurrence is relatively infrequent.

If, as usually happens, cure is not effected, palliative gastrectomy provides for many of the patients submitted to it months or even years of useful, comfortable life. Failing those benefits, at least they are spared some of the suffering which would otherwise be their lot *until the inevitable end occurs.* The chief justification for palliative gastrectomy in carcinoma of the stomach is therefore humanitarian. If it is not done, there is nothing to offer the victim but a painful death. As Churchill said of pneumonectomy in advanced carcinoma of the lung,

it is not correct to call the operation a futile procedure because it does not effect a cure. On the contrary, it should be judged by the fact that it makes the best terms possible with a disease that is already hopeless. Certainly the surgeon who resorts to it has the right to feel that in using it he has fulfilled the highest duty of his profession, "Guérir quelquefois, soulager souvent, consoler toujours."

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